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Proceedings of the Radionuclide Contamination in Water Resources Workshop

Held on May 28 – June 1, 2001
at Almaty, Republic of Kazakhstan

Sponsored by:

The U.S. Department of Energy
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Institute of Nonproliferation – Republic of Kazakhstan
Institute of Hydrogeology and Hydrophysics – Republic of Kazakhstan
KazAtomProm – Republic of Kazakhstan

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Jeffery H. Richardson, Richard B. Knapp, Nina D. Rosenberg, David K. Smith, Andrew F.B. Tompson - Lawrence Livermore National Laboratory
David R. Janecky – Los Alamos National Laboratory
Baurzhan Duisebayev – KazAtomProm, Almaty, Kazakhstan
Olga Tyupkina – Institute of Nonproliferation, Almaty, Kazakhstan
Vasily V. Veselov – Institute of Hydrogeology and Hydrophysics, Almaty, Kazakhstan

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Proceedings

of the

Radionuclide Contamination in Water Resources Workshop

May 28 – June 1, 2001
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Authors

Jeffrey H. Richardson[1]
Baurzhan Duisebayev[2]
David R. Janecky[3]
Richard B. Knapp[1]
Nina D. Rosenberg[1]
David K. Smith[1]
Andrew F.B. Tompson[1]
Olga Tyupkina[4]
Vasily V. Veselov[5]

[1] Lawrence Livermore National Laboratory, Livermore, CA USA
[2] KazAtomProm, Almaty, KZ
[3] los Alamos National Laboratory, Los Alamos, NM USA
[4] Institute of Nonproliferation, Almaty, KZ
[5] Institute of Hydrogeology and Hydrophysics, Almaty, KZ

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Introduction

A workshop entitled *Radionuclide Contamination in Water Resources* was held in Almaty, Kazakhstan from Tuesday 29 May through Friday 1 June. This workshop was co-sponsored by the U.S. Department of Energy, Lawrence Livermore National Laboratory, and three organizations from the Republic of Kazakhstan: the Institute of Nonproliferation, the Institute of Hydrogeology and Hydrophysics, and KazAtomProm. Representatives from the U.S. Department of Energy, three national laboratories, and 13 different organizations from the Republic of Kazakhstan attended the workshop. A complete list of attendees, the workshop program, and information on the background and motivation for this workshop are provided in this report.

The objective of the workshop was to identify critical problems, discover what is known about the problems related to radionuclide contamination of groundwater resources, form collaborative teams, and produce a small number proposals that both address further characterization and assess risk via contaminant fate and transport modeling. We plan to present these proposals to U.S. government agencies and international sponsors for funding.

Background and Motivation

Energy Resources and Regional Stability in Central Asia

The Caspian Sea / Central Asia region is emerging as the world's next major petroleum exporting region. Proven oil reserves are 25 billion barrels (25 BB) and exceed those of the United States (22 BB) and also those of the North Sea (17 BB). Possible oil reserves are comparable to the proven reserves of Saudia Arabia (264 BB).

Western access to these energy supplies is precarious because the stability of the Central Asian region is fragile. There are an abundance of destabilizing forces in the region including severe economic hardship, governments of questionable integrity, illicit drug trafficking, smuggling of nuclear materials, the expansion of Islamic extremism, and degradation of critical natural resources. Degradation of critical natural resources — like potable water — has been shown to exacerbate corrosive social processes and lead to regional destabilization via mass migrations, economic marginalization, an increase in communicable diseases, and increased extremism. Natural resource degradation also directly impacts the ability to produce oil from some parts of the Caspian Basin.

Radionuclide Contamination of Petroleum and Water Resources

The range of natural resource degradation in Central Asia is large but the most critical one is the nuclear legacy of Soviet rule. This legacy is most acutely felt in the radioactive contamination of the critical natural resources in the region. Radioactive contamination effects the production of oil in the Caspian basin[1], it threatens the viability of the Fergana Valley as a major agricultural area[2], and it endangers human health.[3] [4]

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[1] Cherepnin, Y.S., *Radioactive contamination of ground surface and earth bowels resulted from nuclear testing in the areas of Azgir and Kurchatov of the Republic of Kazakhstan*, National Nuclear Center of the Republic of Kazakhstan.

[2] Frantz, D., *Living at ground zero of possible atomic disaster*, New York Times, 21 October 2000.

[3] Firuz, I., *Uranium of Leninabad, Tajikistan: A legacy of radiation*, Asia-Plus News Agency, 3 October 2000.

[4] Zaitseva, L., *The international controversy over the environmental and health impact due to nuclear tests at Semipalatinsk Test Site*, Center for International Security and Cooperation, May, 2001.

The threat of radionuclide contamination to Central Asian water resources was succinctly stated by the New York Times[2]: , "*It could wipe out the way of life that has thrived here for millenniums and threaten the lives and livelihoods of 10 million people in three Central Asian countries*." The three countries referred to are Kazakhstan, Kyrgyzstan, and Uzbekistan and our current focus is on these three countries.

Specific threats from radioactive contamination include:

1. oil producing areas in the eastern Caspian Basin where historic mishandling of naturally radioactive groundwater extracted during oil production has contaminated large areas and discouraged further production by western oil companies[5],
2. groundwater and surface water in the northern Caspian Basin where the detonation of nuclear devices for peaceful purposes (e.g., Azgir) has left a legacy of contamination that acts as a source for radioactive groundwater plumes,
3. the Syr Daria and Amu Daria Rivers where the failure of precariously poised and poorly maintained uranium mill tailings impoundments threatens to contaminate the headwaters,
4. groundwater and soil from uranium mining and ore processing activities (e.g., the Ulba Plant at Ust-Kamenogorsk), and
5. soil, groundwater, and surface water from nuclear weapons testing at Semipalatinsk.

Workshop Concept

The workshop is an outgrowth of an October 2000 fact-finding visit by LLNL staff to Kazakhstan. This visit identified problems related to radionuclide contamination of water resources in Kazakhstan as critical to economic growth, human health, continued oil production, and regional stability.

The magnitude and nature of radionuclide contamination of water resources in Kazakhstan are not well known. First steps are to characterize the contaminant sources and to assess contaminant fate and transport. With these, we can predict the potential impact to water resources and evaluate the risks to human health. The problems can be classified into three categories:

1. Nuclear legacy: The testing of nuclear weapons at Semipalatinsk and elsewhere has caused high levels of contamination over large areas.
2. Oil field fluids: Nuclear devices were detonated in the Caspian region to create gas storage cavities. These cavities are now a source of radionuclide contamination, as are naturally occurring radioactive minerals and formation water extracted from some Caspian Basin oil fields during oil production.

Uranium mining and ore processing: Kazakhstan is a world leader for *in situ* leaching of uranium ore and its processing into fuel for nuclear reactors. These activities have created some environmental issues, including aquifer contamination and threats from uranium tailings ponds.

[5] Tengizchevroil, personal communication.

Results

Five distinct projects were identified at the workshop and project teams were formed to write proposals. The details of this proposal are still being developed. These are described below.

Waste Stabilization and Monitoring at the Ulba Plant

The Ulba Metallurgical Plant (UMP) is a large industrial complex located in northeastern Kazakhtsan in the city of Ust-Kamenogorsk. As part of the workshop, three U.S. and Kazakhstani workshop participants traveled to this site for an orientation tour with specific discussions focused on long-term stabilization of liquid wastes originating from the plant. Uranium has been continuously enriched at this facility since its founding in 1949; the facility represents one of the oldest plants supporting the nuclear cycle in the former Soviet Union. The uranium enrichment supported the nuclear weapons program and the production of reactor fuels for the former Soviet submarine fleet. While the plant's capacity was drawn-down at the end of the Cold War, currently production has been increased to meet demand for reactor fuel. The plant currently supplies most of the 4.4% enriched ^{235}U reactor fuel used by CIS states. In addition to uranium enrichment, the plant also produces BeO, Be alloys and Ta metal for use in civilian, defense, and aerospace applications.

Operations at the plant for four decades has created a significant quantity of legacy waste including actinide, beryllium, and metal by-products which are piped as liquids approximately three kilometers north of the plant and discharged into large retention basins which hold between 25,000 m^3 and 30,000 m^3 of the liquid (Figure 1). There are presently three basins receiving waste and a fourth under construction. Current practice is for the discharge of liquid waste streams into clay-lined retention basins. As the water evaporates, uranium and beryllium precipitates are created that settle out as sediments at the bottom of the basin. The sediments are kept saturated to prevent the airborne dispersal of particulates.

Concern over the long-term disposal practices has led to a proposal to evaluate the waste stream and the long-term stabilization of the waste in the retention basins. The clay lining in one of the basins has cracked and radionuclides and metals have appeared in groundwater samples produced from near-by monitoring wells. Further down-gradient from the waste disposal complex is a municipal water supply well field for the city of Ust-Kamenogorsk that requires further long-term protection; just beyond those wells is the Ertis (Irytsch) River.

The objectives of the proposal are to develop an understanding of the hydrologic flow regime in the vicinity of retention basins, better characterize the radionuclide and metal precipitates and resulting sediments, bound transport processes of actinides and metals through the unsaturated and saturated zones, develop a means to monitor radionuclides in groundwater in adjacent wells, and devise a means to improve the retention qualities of the basin liners. As the new fourth retention basin is brought on line, improvements in waste management practice will also be necessary. Implicit in the proposal is the development of a hydrologic flow model and improvements in knowledge of the site-specific controls on contaminant transport. Ultimately the objective is to develop technologies that permit the closure of the waste facilities with minimal impact to human health and the environment. A priority is to emphasize the transportability of the remedial and management design that allows flow models and information on radionuclide transport developed for UMP to be applied successfully at other sites; in many ways this proposal is a small, tractable demonstration of the applicability of aquifer characterization and modeling as a water resource and environmental hazard assessment tool. An important additional component of this proposal is the initial training in numerical simulation of processes important in aquifer modeling. Thus, this project serves as a template which can be replicated at other sites and by other teams throughout Kazakhstan.

Figure 1: One of three actively used retention basins at the UMP plant in Ust-Kamenogorsk, showing existing discharges and the build up of precipitate wastes.

Assessment of Radionuclide Transport in Semipalatinsk Groundwater

The Semipalatinsk Test Site (STS) in northern Kazakhstan was one of several areas used for the testing of nuclear weapons by the Former Soviet Union. Of a total of 456 nuclear tests carried out at STS, 340 were conducted in underground shafts or tunnels, 30 others were exploded on the ground surface, and the remaining 86 were detonated in the atmosphere. Within the STS, underground testing occurred within tunnels bored into the Degelen Mountain complex (209 tests) and within vertical shafts at the Balapan (109 tests) and Murzhik (26 tests) areas (Figure 2).

Although there has been considerable interest in the distribution and impacts of residual radionuclides produced by the atmospheric testing (e.g., radiologic fallout and dose), there has been far less scrutiny of the fate of residual radionuclides from underground tests and, in particular, their potential to contaminate and migrate in groundwater (e.g., in one case the contaminated groundwater is becoming increasingly in contact with a actively mined coal deposit). Existing efforts have largely concentrated on monitoring programs in wells, rivers, and precipitation discharges from tunnels, and have not focused on examining the future potential for additional contamination or understanding more completely the interconnected processes that lead to such contamination.

These concerns were largely the basis for this proposal, as outlined by a group of participants from the Institute of Hydrogeology and Hydrodynamics (Kazakhstan Ministry of Education and Science), the National Nuclear Center, and LLNL. See *Signed Protocol for Semipaltinsk* at the end of these Proceedings.

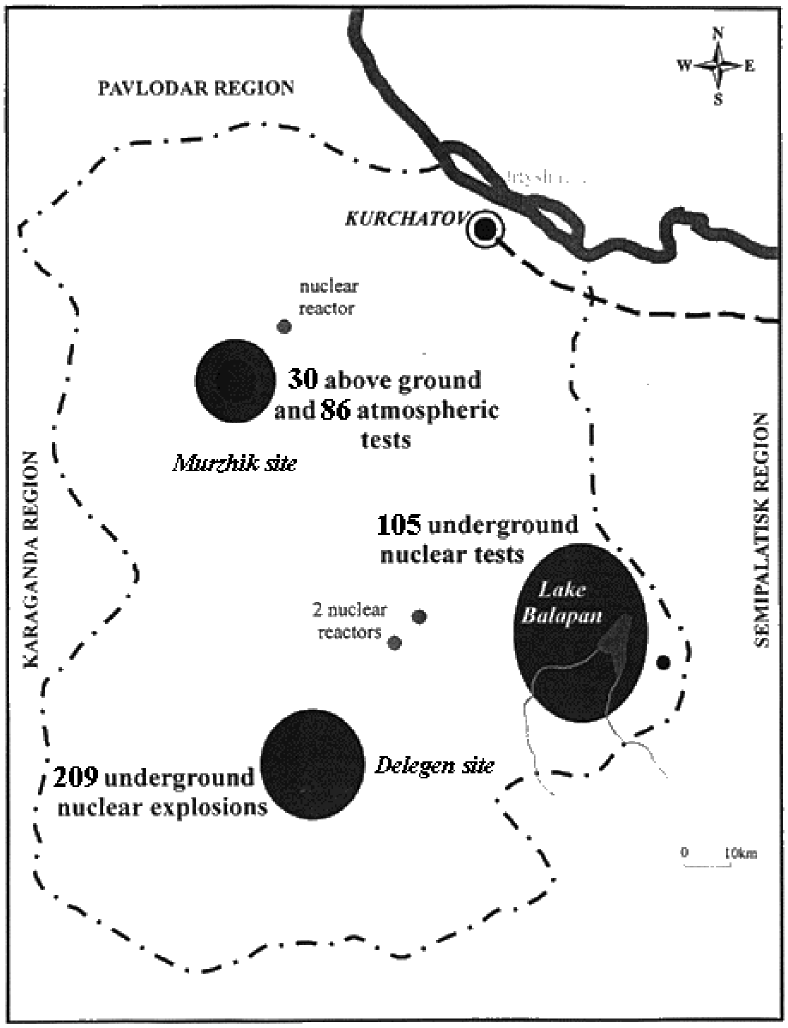

Figure 2: Schematic of the Semipalatinsk Test Site in Northern Kazakhstan with the Balapan area highlighted.

The overarching rationale for the project is based upon the need for preserving the integrity and quality of groundwater resources in Kazakhstan and, in particular, for understanding the nature and magnitude of specific threats to these resources posed by the legacy of underground nuclear testing. The Kazakhstan participants have specifically recommended the Balapan site within the STS be considered for the development of the initial groundwater (hydrodynamic) flow model and the smaller Zarechny site located within Balapan be considered for the development of the initial radionuclide transport model (Figure 3 and attached signed protocol in Appendix H). The models will be used to study the release of radionuclides from one or more underground nuclear tests conducted below the water table and to examine the potential for their eventual migration in groundwater away from the testing areas.

Specifically, this project will emphasize:

1. The nature of radionuclide releases from underground nuclear tests into groundwater, and their subsequent migration in groundwater, to be better quantified and understood;
2. Better and more informed perspectives on these problems to be developed such that existing monitoring data may be better understood or such that future monitoring operations may be better planned;
3. Improved understanding of the risk posed from groundwater contaminated with test-related radionuclides, better management practice for remediation or other reclamation activities, and in general, development of decision-making tools to better evaluate or otherwise modify groundwater use practices in contaminated areas; and
4. Similar analyses to be undertaken at other testing areas within the Balapan area or the STS in general (Figures 2 and 3), or to manage other radionuclide contamination problems not associated directly with underground nuclear testing.

The approach to the model development problem will involve four main components:

1. Evaluate existing data quality and availability;
2. Development of the groundwater flow model;
3. Development of the radionuclide release and transport model with assessments of the controls on radionuclide transport; and
4. Following data management and integration activities throughout the whole process.

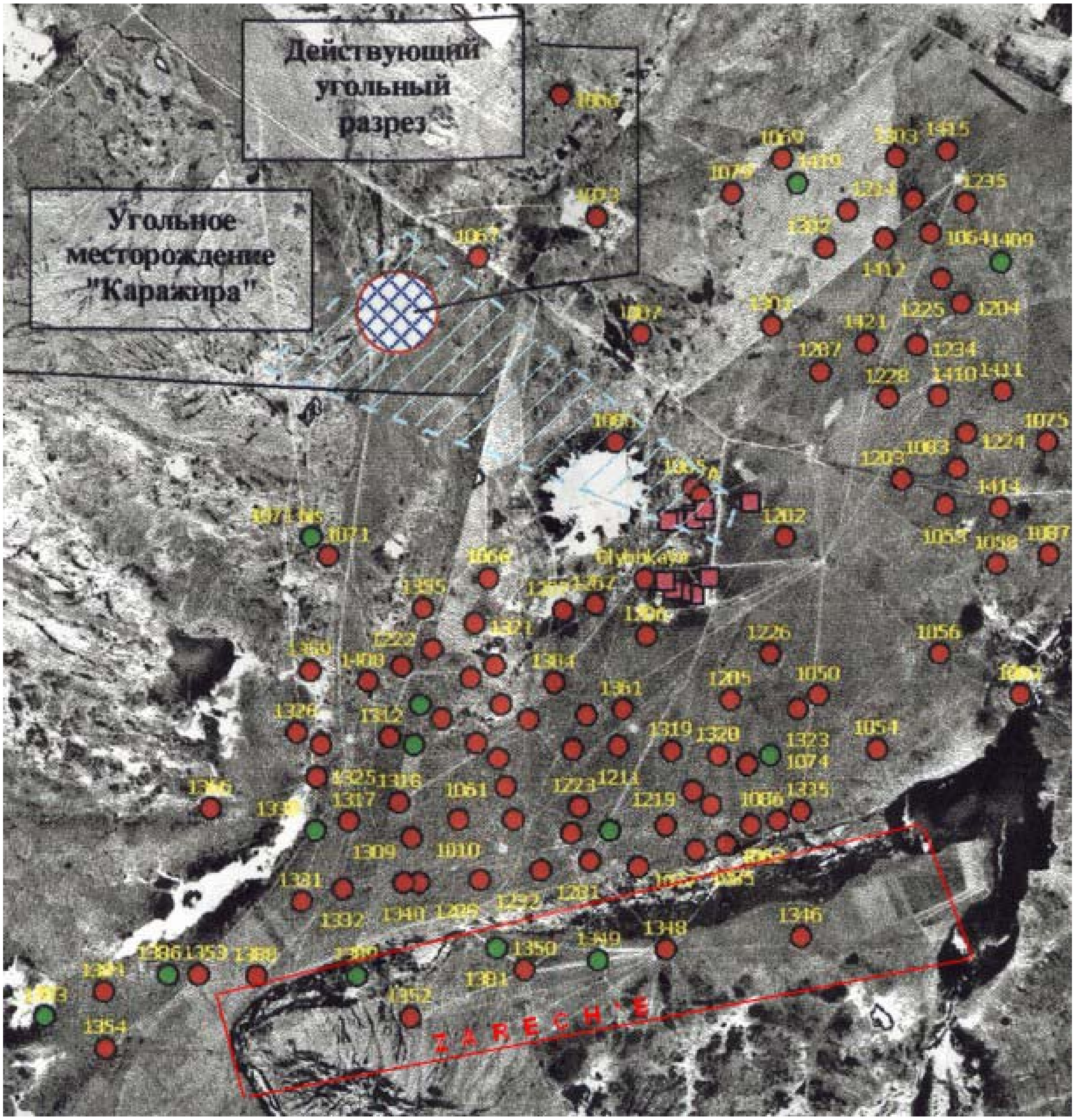

Figure 3: Areal photo of the Balapan area in the Semipalatinsk Test Site in Northern Kazakhstan showing red "military" emplacement shafts and green hydrogeologic boreholes. The smaller Zarechny site is outlined near the bottom of the photo (courtesy: S. Subbotin).

Because the development and application of predictive groundwater flow and transport models can be substantive (and iterative) efforts that take years to complete, the focus of the initial proposal will be on outlining the basic processes required for such an endeavor, so as to form a basis from which more focused, task-oriented proposals can be developed and later combined within the larger framework of the study. The smaller proposals may be targeted for submission, for example, to the International Science and Technology Center (ISTC), International Atomic Energy Agency (IAEA), U. S. Agency for International Development

(USAID), and other relevant agencies that can support collaborative scientific work between the participants.

Ensuring Continued Oil Production from the Caspian Basin

The goal of this proposed project is to prevent unauthorized and accidental oil losses along the entire sequence of oil production to transportation activities. In addition, there is severe radionuclide contamination in some parts of the Caspian Basin. The proposal will also address the characterization and assessment of these risks to full exploitation of the rich petroleum resources.

Oil production from the Caspian Basin has occurred for about a century but only in the last decade have western oil companies been extensively involved in exploration and production activities. Production and refining practices during this century of production were not held to high environmental standards. As a result petroleum pollution within the Caspian Sea, on the PreCaspian land, and within the PreCaspian groundwaters is substantial.

Activities in addition to oil production have exacerbated the situation. These include underground detontation of nuclear devices in the PreCaspian, uncontrolled surface disposal of naturally radioactive groundwater extracted during oil production, leaking highly radioactive liquids from a breeder reactor on the Caspian Sea shore, drowning of oil facilities by the rising Caspian Sea, and flow of polluted waters into the Caspian Sea by the Volga and Ural Rivers. Together these pose a threat to full exploitation of this world class petroleum province and could conceivably result in suspension or severe limitation of current production activities. Finally, the region is politically unstable and a potential target for terrorists.

The proposal will include provisions for physical protection of existing assets, which include production platforms, pipelines, refineries, and staging areas. Both security from attack, unauthorized oil withdrawals, and additional environmental risk is included in our concept of physical protection. A vulnerability assessment is planned as is the development of both a strategy for implementation of remedies and the development of a comprehensive team including all equity partners.

In addition, all radionuclide producing activities, installations and locations will be catalogued and assessed with respect to risk. This will, by necessity, include additional characterization and modeling to fill in gaps in the current data.

Field Verification of Radionuclide Transport in Groundwater

This project is to utilize in situ uranium ore leaching sites in Kazakhstan as field laboratories. The in situ leaching of uranium ore acts as a controlled experiment of the transport of radionuclides in the subsurface. Results from these activities can be used to understand how transport occurs, verify models, and form a basis for predicting the risk associated with radionuclide contaminated groundwater elsewhere. Progress in this area would have broad application across Kazakhstan and in the U.S. as well.

Some key statements regarding radionuclide fate and transport in groundwater can be made from the few studies available at in situ leaching field sites. Colloids transport a significant fraction of the radionuclides at in situ uranium leaching field sites. The importance of colloids as transport agents at other contaminant sites (e.g., Semipalatinsk) is unknown but colloidal transport could greatly amplify the risk if these sites are similar to the in situ uranium leaching field sites. It may be possible to engineer colloidal systems to purge radionuclide contaminants from groundwater but the current state of knowledge is insufficient to do so.

Bioassays for Radiological Risk Assessment of Contaminated Water

This project focuses on the use of microorganisms, such as fungi, as an indicator of bulk risk of waters contaminated by one or more radionuclides was presented. Most current assessments and standards are based on studies using a single contaminant at high dose rates over a short period of time. This proposal expands the knowledge regarding multiple radionuclide aqueous contaminants and their impact on sensitive single-celled, biological indicators. It could represent a quick and more human applicable assay when fully developed.

This proposal has already been submitted to ISTC by the principal investigator and will be endorsed by scientists at LLNL for funding.

List of Attendees

Tleuken Akhmetov
Ministry of Energy and Natural Resources
Advisor to Minister
Astana
Phone/Fax: 7 (3172) 31-71-78

Jakia Arystanbaev
Senior Hydrogeologist
“Volkovgeologia”
168, Bogenbay batyr str.
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 92-60-17; 92-68-14
Fax: 7 (3272) 50-13-59
Email: volkgeo@nursat.kz;
Email: kge39@aport2000.ru

Nikolai Belovolov
National Nuclear Center
Institute of Radiation Safety and Ecology
2 Krasnoarmeiskaya St.,
490021 Kurchatov, Kazakhstan
Phone/Fax: 8 (3225) 12-34-13
Email: irbe@nnc.kz

Sergey Berezin
National Nuclear Center
Head of Division

Peter Chistilin
NAK KazAtomProm
168 Bogenbai batyr str.,
Almaty, 480012 Kazakhstan
Phone. 7 (3272) 69-16-27
Fax: 7 (3272) 50-35-41
Email: bduisebayev@kazatomprom.kz

Valery Demin
National Nuclear Center
Institute of Geophysical Researches
490021 Kurchatov, Kazakhstan
Phone: 8 (3225) 12-37-12
Fax: 8 (3225) 12-34-22
Email: igr@nnc.kz

Valentina Dorofeeva
National Atomic Company
Chief Specialist, New Technologies and
Standardization Department
Bogenbai batyr St., 168
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 69 16 27 int 1182
Fax: 7 (3272) 50 35 41

Baurzhan Duisebayev
NAK Kazatompron
Department Head
168 Bogenbai batyr str.,
Almaty, 480012 Kazakhstan
Phone. 7 (3272) 69-16-27
Fax: 7 (3272) 50-35-41
Email: bduisebayev@kazatomprom.kz

Abdikapar Dzhakelov
Institute of Hydrogeology and
Hydrodynamics
Director, Ground Water Resources
Laboratory
Ministry of Education and Science
94 Valikhanov St.
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 91-89-07

Alexander Gagarin
ULBA Metallurgical Plant
Head of Central Research and Development Laboratory
Abay Ave, 102
492026 Ust-Kamenogorsk, Kazakhstan
Phone: 7 (3232) 29-81-72
Fax: 7 (3232) 24-06-83
Email: gagarin@sigma.kz

Yuriy Grinshtein
National Nuclear Center
Institute of Geophysical Researches
GO “Kaskelen”
Phone: 7 (3272) 46-99-02
Phone/Fax: 7 (3272) 46-99-56
Email: igr@kaskelen.almaty.kz

David R. Janecky
Los Alamos National Laboratory
Los Alamos, NM 87545
Phone: 505-665-0253
Fax: 505-665-4955
Email: janecky@lanl.gov

Peter Kayukov
OAO “Volkovgeologia”
168, Bogenbay batyr str.,
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 92-68-14

Igor Kleinbok
The Institute of Human’ and Animal' Physiology, MinSci
32, Akademgorodok,
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 62-38-40
Fax: 7 (3272) 49-18-33

Richard B. Knapp
Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, California USA 94550-9900
Phone: 925-423-3328
Fax: 925-423-1997
Email: knapp4@llnl.gov

Vadim Konovalov
National Nuclear Center
Institute of Geophysical Research
490021 Kurchatov, Kazakhstan
phone: 7 (3225) 12- 37-42
Fax: 7 (3225) 12-34-22
Email: igr@nnc.kz

Melissa Voss Lapsa
Oak Ridge National Laboratory
Box 2008
Oak Ridge, TN 37831 USA
Phone: (865) 576-8620
Fax: (865) 576-7671
Lapsamv@ornl.gov

Sergey Lukashenko
National Nuclear Center
Institute of Nuclear Physics
1, Ibragimova Str.
Almaty, 480012 Kazakhstan
Work: 7 (3272) 546454
Fax: 7 (3272) 546517
Email: lukashenko@inp1.sci.kz

Michael Melent'ev
National Nuclear Center
Institute of Geophysical Research
Laboratory Chief, Geology and Mineralogy
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 46-99-02
Phone: /Fax: 7 (3272) 46-99-56
Email: igr@kaskelen.almaty.kz

Ekaterina Nikitina
The Institute of Microbiology and Virology, MinSci
103, Bogenbai-batyr Str.,
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 91-97-36
Fax: 7 (3272) 91-75-03

Nursultan Ondagan
Institute of Oil and Gas of Atyrau
45, Baymuhnov Str.
Atyrau 465006, Kazakhstan
Work: 7 (3122) 26-18-03
Home: 7 (3122) 22-85-21
Fax: 7 (3122) 26-32-74
Email: mno1977@yahoo.com

Vladimir Yu Panichkin
Institute of Hydrogeology and Hydrodynamics,
Leading Research Fellow
Ministry of Education and Science
94 Valikhanov St.
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 91-46-09
Email: v_panichkin@mail.kz,

Eugeni Pestov
Institute of Geophysical Researches NNC
490021 Kurchatov, Kazakhstan
Phone: 7 (3225) 12-37-12
Fax: 7 (3225) 12-34-22
Email: igr@nnc.kz

Larisa Ptitskaya
National Nuclear Center
Institute of Radiation Safety and Ecology
2 Krasnoarmeiskaya St.,
490021 Kurchatov, Kazakhstan
TelePhone/Fax: 7 (3225) 12-34-13
Email: irbe@nnc.kz

Jeffrey H. Richardson
Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, California USA 94550-9900
Phone: 925-423-5187
Fax 925-422-6434
Email: richardson6@llnl.gov

Nina D. Rosenberg
Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, California USA 94550-9900
Phone: 925- 424-5212
Fax: 925-423-1997
Email: rosenberg4@llnl.gov

David K. Smith
Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, California USA 94550-9900
Phone: 925-423-5793
Fax: 925-422-3160
Email: smith24@llnl.gov

Yuri Stril'chuk
National Nuclear Center
Institute of Radiation Safety and Ecology
2 Krasnoarmeiskaya St.,
490021 Kurchatov, Kazakhstan
Phone/Fax: 7 (3225) 12-34-13
Email: irbe@nnc.kz

Eugeny D. Stukin
Institute of Global Climate and Ecology
20-B, Glebovskaya Str.,
Moscow 107258
Russia

Sergey Subbotin
National Nuclear Center
Institute of Nuclear Physics
16 Oktyabr'skaya St.
490021 Kurchatov, Kazakhstan
Phone: 7 (3225) 12-24-41
Fax: 7 (3225) 12-24-41
Email: subbotin@nnc.kz; kurlab@nnc.kz

M. Kay Thompson
Office of International Affairs
United States Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Phone: 202-586-7997
Fax: 202-586-0823
Email: kay.thompson@hq.doe.gov

Yaroslav Tichshenico
Institute of Nonproliferation
4, Chaikinoi Street
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 545137
Yart_999@hotmail.com

Andrew F. B. Tompson
Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, California USA 94550-9900
Tel: 925-422-6348
Fax: 925-423-1997
Email: afbt@llnl.gov

Olga Tyupkina
Institute of Nonproliferation
4, Chaikinoi Street
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 534809
Fax: 7 (3272) 534721/Cell 3007 116 169
ainp@nursat.kz

Vasily Veselov
Institute of Hydrogeology and Hydrophysics
94 Valikhanov St.
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 91-50-51
Fax: 7 (3272) 91-88-25
Email: v_veselov@chat.ru

Natalia Vetrinskaya
Institute of Geophysical Researches
Geophysical Observatory "Kaskelen".
191, Abaya Ave.,
Almaty, 480012 Kazakhstan
Phone: 7 (3272) 46-99-02, 46-99-56
Fax: 7 (3272) 46-99-56
Email: igr@kaskelen.almaty.kz

Workshop Photograph

Figure 4: Attendees at *Radionuclides in Water Resources* Workshop

Agenda

May 28, Monday
12:00 – registration in the Hotel "Kazakhstan"
14:00 – visit Medeo and Chymbulak

May 29, Tuesday
09:00 – opening remarks

24 Ministry of Energy and Mineral Resources (T.Ahmetov*)
25 S. Berezin (KZ NNC)
26 K. Thompson (DOE)
27 J. Richardson (LLNL)
28 O. Tyupkina (AINP)
29 Group Photo

10:30 – coffee-break

11:00 – Section: Ensuring environmental safety from anthropogenic contaminant sources
Co-chairman – V. Veselov
Co-chairman – N. Rosenberg

5. 11-05 - A. Gagarin – UMZ
Development of a technology of decommission and long-term stabilization of the OAO UMZ waste depot

5. 11-25 - Ya. Arystanbayev – Volkovgeologiya

   Development of criteria and input dates for burial of radioactivity waste from oil fields in Caspian region on common square of 3370 sq.km.

1. 11-35 - Ibrayev R. – AINP

   Ensuring environmental safety from oil-gas infrastructure impact in Kaspian. region: Stage 1 – Problem and technology analyses

11:45 – Discussion

12:30 – Lunch

14:00 – Section: <u>The legacy of underground explosions</u>

Co-chairman – O. Tuypkina

Co-chairman – J. Richardson

2. 14-00 - V. Veselov - IGG

   Estimation of radioactive pollution danger of underground water of the Semipalatinsk Test Site by methods of mathematical and geoinformation modeling and development of recommendations on risk lowering

3. 14-15 - O. Nursultan – State University, Atyrau

   Ecological problems developed in Western Kazakhstan as a consequence of radionuclide pollution of Western Kazakhstan and the ways to solve them

4. 14-30 – O.Tyupkina – AI N

   Conversion of Semipalatinsk Test Site

5. 14-45 - V. Konovalov – IGR NNC

   Study of radionuclide contamination of subsoil and fracture waters of underground river basin of the Degelen mountain range and adjoining territory

   Study of the danger of radionuclide contamination of the Irtysh river by subbed and surface water of the Chagan river

15-00 – Coffee-break

6. 15-20 - Vetrinskaya N. – GO «Kaskelen»

   Investigation of natural water quality (ecological aspect) of the former Semipalatinsk Test site using biological objects of different classification groups

7. 15-30 - Melentiev – GO «Kaskelen»

   Radioniclide contamination of underground water of Balapan Ground in the Semipalatinsk Test Site

8. 15-40 - Subbotin S. – INP

   Organization of a Groundwater Monitoring System at Semipalatinsk Test Site

9. 15-50 – Stril’chuk Yu.

Study of radionuclide and heavy metal content and migration in landscapes of Degelen mountain

10. 16-00 – Ptitskaya L.

    Study of radionuclide and their forms present in bottom sediment of closed water bodies at former Semipalatinsk Test Site

11. 16-10 – Belovolov N.

    Study of radionuclide transport by ground water at Semipalatinsk Test Site in order to predict possible effects of drinking water and geological environment radioactive contamination

16:20 – Coffee-break

16:40 – Discussion

18:00 – End discussion

18:30 – Reception

May 30, Wednesday
Field trips to Ust-Kamenogorsk and the Aksuek mine

May 31, Thursday
09:00 – Section: Uranium mining and technogenic contamination of water resources
Co - chairman – B. Duisebayev
Co - chairman – R. Knapp

12. 09-00 - Arystanbayev Ya. – Volkovgeologia

    The learning sorptive-capacity properties in laboratory conditions and experimental-industrial trials of natural zeolite as a filtrate on clearing underground waters polluted by radionuclides

13. 09-15 - Kayukov P. – Volkovgeologia

    Definition of features of a geological hydro-geological section for the characteristic of paths of radionuclides migration

14. 09-30 - Chistilin P. – Kazatomprom

    Searching of the technogenic dispersive-colloidal mineralisation of composite neutralized, sorption, reduced barrier formed by an underground hole leaching

09:45 – Section: Study of water resources by remote sensing theme

09:45-10:00 – Report on “Remote sensing” theme

10:00-10:30 - Discussion

10:30 – 11:00 - Coffee-break

11:00 – Section: *Formation of project proposals*
Co-chairman – O. Tyupkina, AIN
Co-chairman – J. Richardson, LLNL

11:00-12:00 – Discussion of questions # 1-5

12:00-12:45 (Executive Committee) – Formation of themes and working groups by joint projects

13:00 – Lunch

14:30 –16:30 – Discussion of projects and proposals in groups. Preparation of the seminar results

16:30-17:00 –Working discussion on preparation of projects

17:00 –18:00 –Team leaders reports. Formal closure.

June 1, Friday
09:00 – Work with selected proposals

Chymbulak Field Trip

On Monday 28 May, a small bus took the Americans and most of the Kazakhstani workshop participants to a beautiful mountain site in the foothills of the Zailiysky Altau, part of the Tian Shan range, for an afternoon visit. The motivation for the trip was to provide an informal opportunity for interaction between the participants before the formal part of the workshop began on Tuesday. Medeo is the name for a huge ice rink complex about 15 km from central Almaty and Chymbulak is the name of the nearby skiing center. After riding on chair-lifts, taking lots of photographs, and enjoying the views and fresh mountain air, we all sat down for a dinner at a ski lodge before returning to the hotels. The trip provided an excellent beginning to our workshop.

Figure 5: *Radionuclides in Water Resources* attendees on Chymbulak field trip.

Ulba Plant, Ust-Kamenogorsk Field Trip

Three U.S. (Richardson, Tompson, Smith) and five Kazakhstani (Duisebayev, Gagarin, Dorofeeva, Tichshenico Tyupkina) participants made a one-day site visit to the Ulba Metallurgical Plant in the city of Ust-Kamenogorsk in northeastern Kazakhstan, approximately 900 km from Almaty, on Wednesday, May 30. Victor P. Feodoro, Production Safety Director, ULBA Metallurgical Plant joined this group at the site. The Ulba Metallurgical Plant (UMP) is a large industrial complex located near city center (Figure 6). The plant was founded in 1949 to extract uranium from ore and supply enriched uranium and beryllium for atomic defense and naval reactors for the former Soviet Union. The plant represents one of the oldest facilities supporting the nuclear cycle in the former USSR and, as relayed by our hosts, is the world's largest uranium processing plant. After the end of the Cold War, production of enriched uranium and metals diminished. However in the last decade, demand for reactor fuel in CIS states has increased as has the need for beryllium (Be) and tantalum (Ta) metal in the civilian, defense, and aerospace sector. The UMP supplies most of 4.4% enriched ^{235}U reactor fuel used by CIS states and meets a strong international market for BeO, Be alloys, Be ceramics, Ta, and niobium (Nb).

Figure 6. Areal view of Ulba Metallurgical Plant (UMP) in Ust-Kamenogorsk.

Figure 7: Piping system conveying liquid wastes from the UMP plant (3 km in background) to the retention basins.

The primary objective of our visit was to assess and evaluate UMP's waste disposal practices with the immediate objective of developing technologies to stabilize the current groundwater contamination problem (below), and an ultimate objective of providing guidance in the development of longer term waste disposal strategies. Over nearly fifty years of continuous operations the plant has generated a significant quantity of legacy waste including actinides, beryllium, and metal by-products in solution (and eventually as solid precipitates). On-going practice is for the liquid effluent to be piped approximately three kilometers north of the plant and discharged into three large retention basins each with a capacity of between 25,000 m^3 and 30,000 m^3 of liquid (Figures 1 and 7).

A fourth retention basin is presently under construction (Figure 8). The three operational basins are each filled with standing water (~ pH 8.0) and lined with clay and synthetic liners to attenuate infiltration of contaminated fluids. As the water evaporates, uranium and beryllium precipitates are created that settle out as sediments at the bottom of the basin. The sediments are kept saturated to prevent the airborne dispersal of particulates by controlling the level of water in the basin.

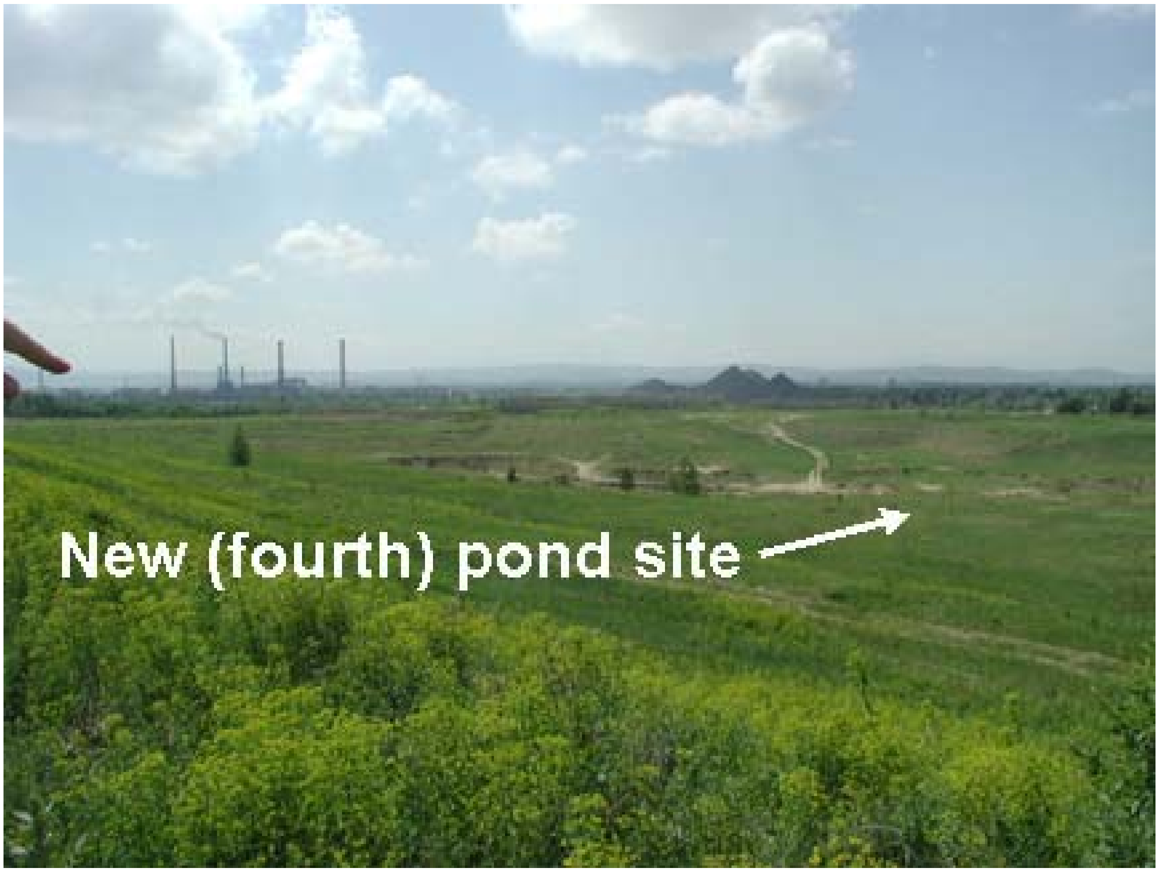

Figure 8: Fourth retention basin under construction at the UMP plant.

One of the older discharge basins is leaking (Figure 9). Standing water was let to completely evaporate out of basin "1-3" which resulted in the desiccation, cracking, and compromise of its clay and synthetic liners. Rainwater and snow melt subsequently allowed to collect in the pond, leak through the liner, and infiltrate to groundwater. Dissolved metals have subsequently appeared in groundwater samples produced from near-by monitoring wells. The threat to a municipal water supply well-field for the city of Ust-Kamenogorsk situated down-gradient from the disposal facility is real. In addition a sediment "beach" containing a thick pile (several meters) of uranium and metal precipitates (sediments) in the northeastern corner of the 1-3 retention basin is partially exposed to the atmosphere; only 30% of the beach is presently covered by a clay cap.

During the site visit we met with the deputy director of plant and his senior staff for representing research, safety, and facility directorates. We spent considerable time at the disposal facility where we toured the disposal ponds, the retention basin currently under construction, and the effluent piping and discharge system. Ensuing discussions centered around making realistic simulations of the regional groundwater flow and superimposing the hydrologic effects of the waste operations on the system. Potential pumping scenarios were discussed to keep the dissolved or suspended contaminants from compromising the public water supply wells. Radiochemical and inorganic analyses are necessary to determine the matrix characteristics of the actinide and metals precipitates and bound transport predictions. Effective liners and lining materials will be required to attenuate radionuclides within the disposal basins. Groundwater protection strategies are contingent upon a reliable means to detect radionuclides in monitoring wells. In addition, UMP desires an optimum design for the fourth retention basin currently under construction both for the protection of groundwater resources and to efficiently manage future liquid waste streams within the plant's limited remaining real estate.

Over the long term, the basins will have a finite lifetime, either because precipitate build up will decrease their capacity or because the integrity of the lining system will ultimately diminish. The performance of the pond disposal system as a whole may also be susceptible to interruptions in the inflows and other operational problems that could occur at the plant. Because there is little new land for more ponds and because the plant as a whole is an extremely viable and productive enterprise, longer term disposal or treatment technologies for the waste stream that do not rely on the ponds may become of interest.

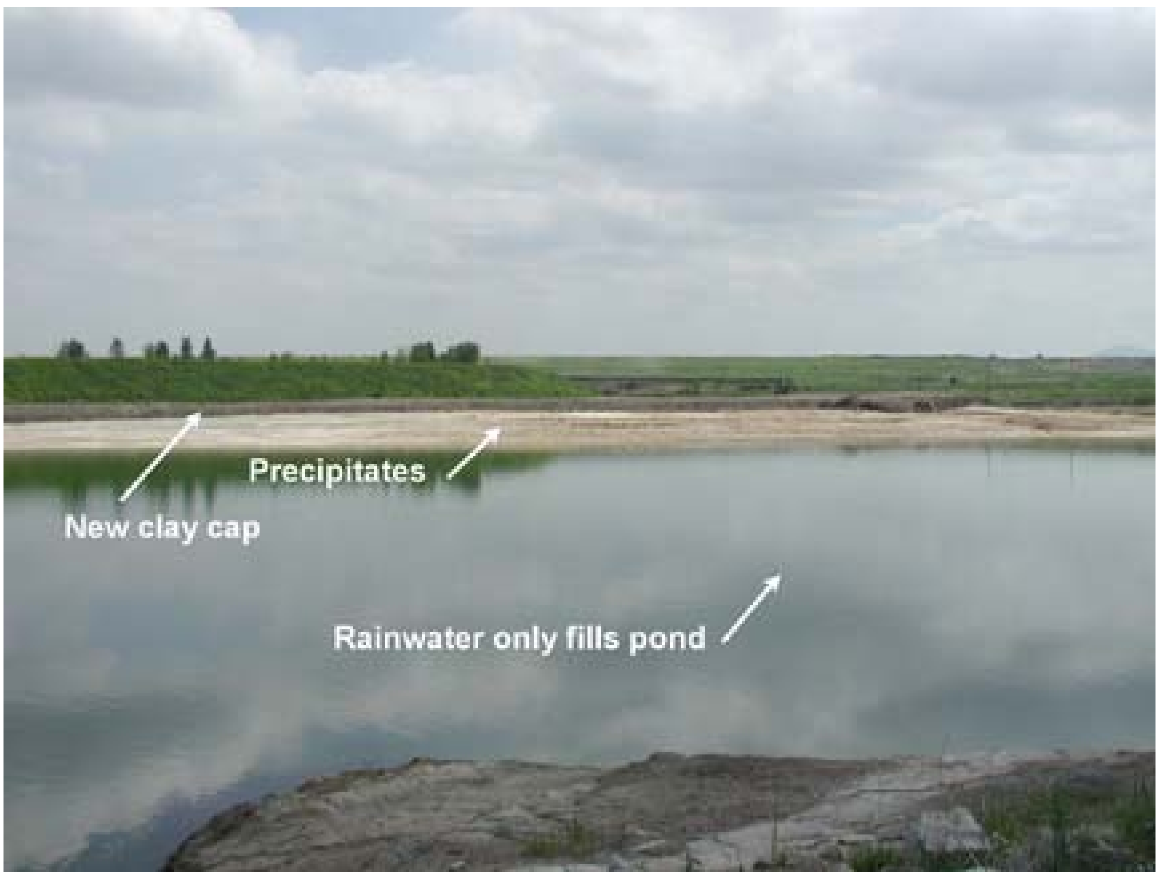

Figure 9: Closed retention basin "1-3" at the UMP plant showing the build up of precipitate wastes as a "beach" and the current construction of a protective clay cap. Water in this basin is now accumulated only from rain and snowmelt runoff.

Aksuet Mine Field Trip

The Aksuet mine was visited on Wednesday 30 May. The Aksuet mine is located about 300 km northwest of Almaty, near the southwest tip of Lake Balkash. It is an isolated location on the steppes of Kazakhstan and was discovered in the late 1940's; production started in 1957 . At Aksuet, uranium ore was mined underground from hard rock until the break-up of the Soviet Union, when all uranium mining and production activities were terminated. It currently crushes barite ore mined at a near-by location to produce a fine powder used in oil drilling fluids.

During uranium mining operations, excavated rock containing uranium but at concentrations below then commercial grade was disposed in a huge pile at the surface (figure 10). Later, when technologies had improved, the uranium in this pile became commercial grade and leaching operations were conducted to extract more uranium. Readings at the pile's surface are typically at 100 μR/hr (international standards are 60 μR/hr) with maximum radioactivity at 500 μR/hr.

The hazards at Aksuet are three-fold. The greatest risk arises from wind-blown particles from the radioactive waste pile. During half of the year, the steppe wind blows strongly from northeast to southwest, which bring air-borne particles from the pile to the nearby (3-5 km) mining town (current population about 2,000). The wind blows in the reverse direction during the remaining half-year. There are no measurements of air-borne particles. The risk is restricted to the town and can not be quantified.

The second risk is from rain water percolating into the mine below and transporting radionuclides to the groundwater. This risk is not seen as significant. One of the mining tunnels collapsed during mining operations and created a crater at the surface (figure 11). Any rain (about 250 mm/yr) will penetrate into the mine workings through this collapse structure. But, in general, the mine is dry and the water table is greater than 900 m below the surface so any radionuclide transport is most like small and confined.

The third risk is from radon leakage from the mine shaft (Figure 12). Work is currently underway to seal this shaft but the possibility of radon leakage shifting to the collapse crater (Figure 11) has not been explored.

Figure 10: The uranium mining waste pile of concern at Aksuet. An adjacent pile is composed of non-radioactive rocks with a grain size from crushed rock to boulder; these materials could be used as a cover material for the radioactive pile shown.

Figure 11: Surface collapse structure created by caving of underground mine workings at the Aksuet Mine.

Figure 12: Aksuet mine shaft and associated buildings.

Post-Workshop Proposals Received

Assessment of Radionuclide Migration in Groundwater at the Semipalatinsk Test Site
(DRAFT PROPOSAL SUBJECT TO REVISION)

1. Participants

Ministry of Education and Science, Institute of Hydrogeology and Hydrodynamics, Republic of Kazakhstan,

Prof. V. V. Veselov, Institute Director, v_veselov@chat.ru,
A. K. Dzhakelov, Director, Ground Water Resources Laboratory,
V. Yu. Panichkin, Leading Research Fellow, v_panichkin@mail.kz,

National Nuclear Center, Republic of Kazakhstan,

M. I. Melentyev, Laboratory Director, Institute of Geophysical Research, igr@kaskeken.almaty.kz
V. E. Konovalov, Department Head, Institute of Geophysical Research, igr@nnc.kz,
S. B. Subbotin, Leading Engineer, Institute of Nuclear Physics, subbotin@nnc.kz, kurlab@nnc.kz

Lawrence Livermore National Laboratory, University of California and U. S. Department of Energy, USA

J. H. Richardson, Deputy Program Leader, PPAC Program, richardson6@llnl.gov,
D. K. Smith, Radiochemist, Analytical and Nuclear Chemistry Division, smith24@llnl.gov
A. F. B. Tompson, Hydrologist, Geosciences and Environmental Technologies Division, afbt@llnl.gov

2. Primary Objectives

The purpose of this document is to summarize the principal features of a joint effort to develop an intermediate scale computer model of groundwater flow and radionuclide transport at the Semipalatinsk Test Site (STS) in northern Kazakhstan (Figure 1), as agreed to by the participants on June 1, 2001. The Kazakhstan participants have specifically recommended the Balapan site within the STS be considered for the development of the initial groundwater (hydrodynamic) flow model and the smaller Zarechny site located within Balapan be considered for the development of the initial radionuclide transport model (Figure 2). The models will be used to study the release of radionuclides from one or more underground nuclear tests conducted below the water table and to examine the potential for their eventual migration in groundwater away from the testing areas.

Because the development and application of predictive groundwater flow and transport models can be substantive (and iterative) efforts that take years to complete, the focus of this document will be on outlining the basic processes required for such an endeavor, to form a basis from which more focused, task-oriented proposals can be developed and later combined within the larger framework of the study. The smaller proposals may be targeted for submission, for example, to the International Science and Technology Center (ISTC), International Atomic Energy Agency (IAEA), U. S. Agency for International Development (USAID), and other relevant agencies that can support collaborative scientific work between the participants.

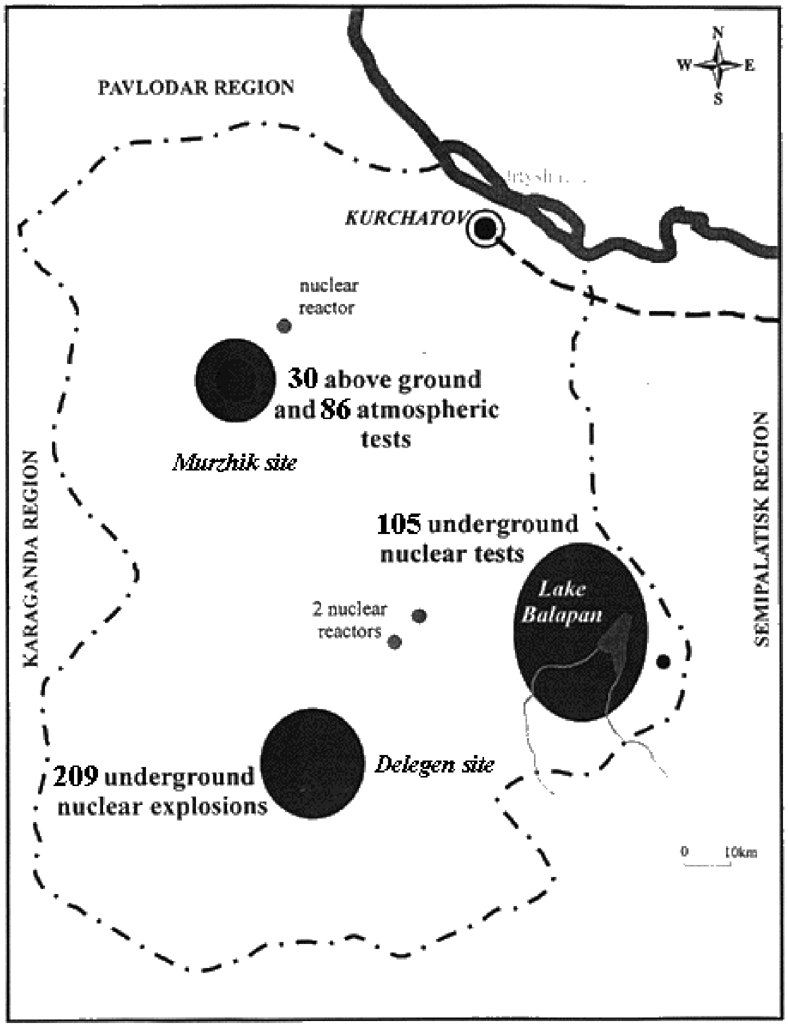

Figure 1: Schematic of the Semipalatinsk Test Site in Northern Kazakhstan with the Balapan area highlighted.

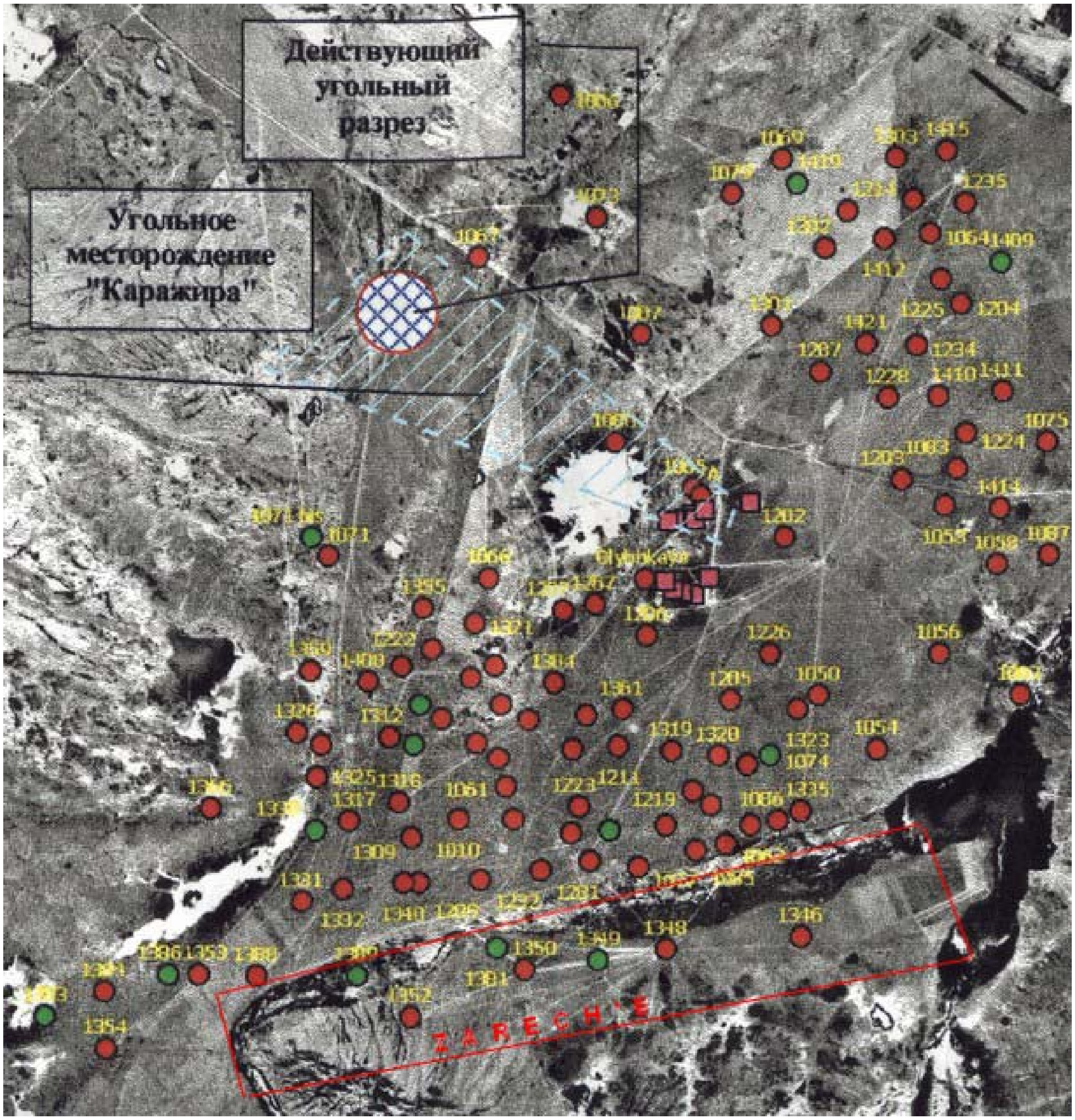

Figure 2: Areal photo of the Balapan area in the Semipalatinsk Test Site in Northern Kazakhstan showing red "military" shafts and green unused boreholes. The smaller Zarechny site is outlined in the bottom (courtesy: S. Subbotin).

3. Background and Rationale

The Semipalatinsk Test Site (STS) in northern Kazakhstan was one of several areas used for the testing of nuclear weapons by the Former Soviet Union (Mikhailov et al., 1997). Of a total of 456 nuclear tests carried out at STS, 340 were conducted in underground shafts or tunnels, 30 others were exploded on the ground surface, and the remaining 86 were detonated in the atmosphere. Within the STS, underground testing occurred within tunnels bored into the Degelen Mountain complex (209 tests) and within vertical shafts at the Balapan (109 tests) and Murzhik (26 tests) areas (Figure 1).

Although there has been considerable interest in the distribution and impacts of residual radionuclides produced by the atmospheric testing (e.g., radiologic fallout and dose), there has been far less scrutiny of the fate of residual radionuclides from underground tests and, in particular, their potential to contaminate and migrate in groundwater and other drinking water supplies in the STS area (IAEA, 1998). Existing efforts have largely concentrated on monitoring programs in wells, rivers, and precipitation discharges from tunnels, and have not focused on examining the future potential for additional contamination or understanding more completely the interconnected processes that lead to such contamination[5].

The overarching rationale for the project is based upon the need for preserving the integrity and quality of groundwater resources in Kazakhstan and, in particular, for understanding the nature and magnitude of specific threats to these resources posed by the legacy of underground nuclear testing. Based on the hydrologic setting and nature of the nuclear tests conducted there, the Kazakhstan participants have specifically identified the Balapan site within the STS for the development of a hydrologic flow model and the smaller Zarechny site located within Balapan for the development of the initial radionuclide transport model. The models will be used to study the release of radionuclides from one or more underground nuclear tests conducted below the water table and to examine the potential for their eventual migration in groundwater away from the testing areas.

Specifically, the overall project will emphasize:

6. The nature of radionuclide releases from underground nuclear tests into groundwater, and their subsequent migration in groundwater, to be better quantified and understood;
7. Better and more informed perspectives on these problems to be developed such that existing monitoring data may be better understood or such that future monitoring operations may be better planned;
8. Improved understanding of the risk posed from groundwater contaminated with test-related radionuclides, better management practice for remediation or other reclamation activities, and in general, development of decision-making tools to better evaluate or otherwise modify groundwater use practices in contaminated areas; and
9. Similar analyses to be undertaken at other testing areas within the Balapan area or the STS in general (Figures 2 and 3), or to manage other radionuclide contamination problems not associated directly with underground nuclear testing.

[5] In one case the contaminated groundwater is known to be coming in contact with a actively mined coal deposit

It is worthy to mention that similar endeavors have been initiated at the US testing areas at the Nevada Test Site (e.g., USDOE 1997) and at the French testing areas in the South Pacific (e.g., IAEA, 1998 b,c,d).

4. Approach

The approach to the model development problem will involve four main components:

6. Evaluate existing data quality and availability;
7. Development of the groundwater flow model;
8. Development of the radionuclide release and transport model with assessments of the controls on radionuclide transport; and
9. Following data management and integration activities throughout the whole process.

The middle two will be discussed separately below. Because it is our contention that "data availability, quality, management and integration" is a process that will accompany each modeling effort, with specific data and monitoring needs pertinent to the migration of test-related radionuclides in groundwater (e.g., Borg et al., 1976), these aspects will be discussed in parallel with the flow and transport modeling approaches.

4.1 Groundwater Flow Model. The particular groundwater flow model to be used in this project will be determined at a later date. In general, it should be three-dimensional and allow for transient, multi-layer problems to be addressed. Key elements of groundwater flow model development should include (e.g., Veselov and. Spivak, 1997):

4.1.1. An assessment of model needs and a comparison of these needs with available data at the modeling site. Data needs will include, but not be limited to,

1. An understanding of the principal hydrostratigraphic layers and geologic structures that control or affect groundwater flow,
2. Hydrogeologic data associated with these layers, such as permeability (or hydraulic conductivity), effective porosity, temperatures and their spatial variation, water level or pressure head data and important transient variations of these variables,
3. Important sources of recharge or discharge, such as pumping or injection wells, meteoric inputs, and discharge or recharge associated with important surface water bodies such as rivers or lakes,
4. An understanding of important boundary and initial conditions that may be used, through iteration, to optimize the design of the modeling grid.

4.1.2. Development of a model grid with appropriate assignment of material properties, initial conditions and boundary conditions. *This will essentially embody our most complete understanding of the system as a whole, incorporating existing structural data, and parametric* *information, and geologic interpretations, and should be subject to revision as a result of acquiring new data or other calibration adjustments.*

4.1.3. Development of a cycle of model calibration. Calibration is a process of

15. Running a groundwater flow model,
16. Seeking consistency of the solution (e.g., water levels, pressures, inferred flow velocities, travel times, or groundwater ages) with measurements of the same variables,
17. Adjustment of model parameters and other interpretational data, possibly as a means to help prioritize acquisition of new data to improve or further constrain model performance,
18. Rerunning the model to repeat the process.

4.2 Radionuclide Release and Transport Model. The particular radionuclide transport model to be used in this project will be determined at a later date. Key elements of the this model should include

4.2.1. An analysis of simple flow pathways in the calibrated flow model, as a means to assess transport pathways away from testing locations or estimate groundwater sources and ages. Geochemical (isotopic data) may often be available to estimate the sources of groundwater and groundwater ages. These can be used as an additional means of flow model calibration (section 4.1.3).

4.2.2. An assessment of transport model needs and a comparison of these needs with available data at the modeling site. Data needs will include, but not be limited to

10. Existing measurements of radionuclides in groundwater, their concentrations, and, potentially, additional information that may distinguish whether they exist in colloidal or dissolved states;
11. An understanding of the groundwater chemistry, which may include measurements of pH, Eh, Total Dissolved Solids (TDS); major cations and anions, as well as particular isotopic compositions ($^{18}O/^{16}O$, $^{2}H/^{1}H$, ^{3}H, ^{3}He, ^{14}C, etc.);
12. An understanding of the mineralogic content of the geologic media that includes volume fraction measurements of key reactive minerals such as iron (or other metal) oxides, zeolites, and clays, especially in the vicinity of the testing areas;
13. Estimates of diffusive, dispersive, and, if relevant, matrix diffusion parameters associated with the geologic media.

4.2.3. An assessment of the key test-derived radionuclides of concern and their respective residual (post-test) inventories (total masses or activities) at the testing locations of interest. For a given testing location, this information comprises the Radiologic Source Term (RST) of the test (e.g., Wild, et al., 1998).

4.2.4. An assessment of the form and distribution of the RST in the immediate region surrounding each test of interest. *It is well known that many of the refractory radionuclides will be sequestered within a melt glass phase lining the bottom of the test cavity, while volatile radionuclides will be distributed in and about the cavity and disturbed geologic media surrounding each test (e.g., Smith, 1995).*

4.2.5. An assessment of a time frame of interest. Different radionuclides have different half-lives – some lasting thousands or more years – and are involved in decay chains that serve to alter the composition of the RST over time. It is important to identify a time frame over which the analyses will occur and over which the composition of radionuclide contanmination will be of interest (e,g, 10, 100, 1000 or more years).

4.2.6. An assessment of the processes associated with the release of radionuclides in the RST into groundwater. For a given testing location, this information comprises the Hydrologic Source Term (HST) of the test (e.g., Tompson, et al., 2000).

4.2.6. An assessment of the reactions associated with radionuclides in groundwater. This may include identification of important dissolved radionuclides species and their solubilities, principal precipitation or dissolution reactions associated with these radionuclides, and parameters associated with surface complexation and ion exchange (e.g., sorption) of these radionuclides onto reactive minerals in the system. Sorption reactions serve to retard the migration rates of many important radionuclides (like Pu and U) relative to groundwater (e.g., Tompson, et al., 2000)..

Note: The representation of *radionuclide release and reaction* mechanisms in a transport model can become quite complicated, both in terms of the numbers of processes involved and in terms of the mathematics required to achieve correct solutions. It is thus recommended that initial efforts pursue the simplest and most tractable approaches for accommodating these processes in the models. Additional levels of complexity can be incorporated as time, data, and confidence permit in the future.

4.2.7. Development of a cycle of transport model calibration. Because model forecasts may need to last tens or hundreds of years, the process of calibration may be somewhat limited. Should appropriate observational data exist, it can involve

30 Running a transport model with a plausible flow model result as a means to estimate simple flow pathways or to estimate groundwater sources and ages for additional flow model calibration purposes (section 4.2.1);

31 Comparison of predicted radionuclide concentrations with any measurements.

5. References

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Evaluation of radionuclide contamination and safety of oil and gas facilities at the Caspian region

Project Duration: 15 months

Estimated Project Cost: $274,285

Scope of the Project: Evaluation of radionuclide contamination and safety of oil and gas facilities at the Caspian region

Organizations-Participants of the Project:

Association "Institute of Non-proliferation"
NAK KazAtomProm
KATEP
RSE "National Nuclear Center of the Republic of Kazakhstan"
Research Institute at the Atyrau State University
OJSC "Volkovgeologia"

Introduction and Overview:

At the present Kazakhstan is experiencing a rapid growth of the oil and gas industry. Many foreign companies are interested in development of the infrastructure of oil and gas mining and transportation. Most of oil&gas objects/facilities are located at the Caspian region. The oil and gas bearing area is about 1.7 mln.sqr.km while the territory of Kazakhstan is 2.7 mln.sqr.km. According to the estimate of specialists 7% of the Kazakhstani reserves are discovered by the present time. The oil and gas industry of Kazakhstan is going to be one of the key sectors of the Kazakhstani economy in the nearest decades.

Along with development of the oil and gas industry the issue of radionulclide contamination of oil and gas deposits, facilities, as well as territories at the Caspian region is arising to the forefront. Kazakhstan possesses 25% of world uranium reserves. Besides acting mining and processing uranium productions there are lots of dumps and wastes from the former Soviet Union. Thus, the Caspian region is "abundant" of either oil and gas reserves either object of uranium mining and processing and polygons (test sites), where nuclear tests were conducted during the Soviet era. Existence of coal deposits and deposits of other minerals with associated radionuclides, and corresponding mining and processing industries, influence on the radionuclide contamination status as well.

In the framework of the Project it is proposed to classify oil and gas objects/facilities and objects-sources of contamination; to systematize existent information about radionuclide contamination; to process and analyze remote sensing data and satellite images; to map main objects, which affect the ecosystem of the Caspian region; to evaluate the level of radionuclide contamination of oil and gas objects/facilities; to determine the main ways of contamination; to evaluate the level of physical safety/protection of oil and gas facilities; to model possible regular and emergency situations; and to develop recommendations on enhancement of control and monitoring systems.

Tasks/Stages of implementation of the Project:

1.0 Creation of database of objects

1.1 Classification of oil and gas industry objects

In the framework of this Task it is proposed to compile a database of oil and gas objects including objects of oil and gas mining, processing, oil and gas pipelines, control and storage facilities, auxiliary facilities. Besides general information about objects the database shall consist the following data: production technologies used, equipment used, methods of control, raw materials used in process, type and volume of production, cases (accidents) of ecological and/or safety violations with causes analysis, illegal actions, attempts of illegal trade of thefts.

1.2 Classification of objects-sources of contamination in the region

It is proposed to create a database of objects, which are potentially sources of radionuclide contamination in the Caspian region. The database shall include acting objects as well as objects were in use in the past. The following objects shall be included into the database:

Nuclear objects, which are located at the Caspian region. They will include the polygons (test sites), where the nuclear tests were conducted during the Soviet era;

Objects of mining and processing of uranium, coal and other minerals related to radionuclides;

Dumps and wastes of uranium mining and processing;

Dumps and wastes of coal mining and processing;

Wastes from electric power stations.

Task duration: 6 months.

Cost estimate:

##	Activity / Expenditures	Duration, month	Labor, man/month	Cost, $
1	List of companies and objects at the Caspian region	1	6.5	3640
2	Research methodology	1.5	7.75	4340
3	Research Instruments	0.5	6.85	3840
4	Pilot testing	0.5	3.1	1700
5	Data collection	1	5.75	3250
6	Data processing and analysis	1.5	8.6	4850
7	Results check	1	1.5	800
8	Deep Interview	1	4.2	2350
9	Travels			12000
10	Communication			2400
	Subtotal:			39170

2.0 Training

For successful and the most effective processing and analysis of materials under the follow-on Tasks it is proposed to conduct a certified training for specialists. The trainings shall be on:

Geo Information Systems software package (ArcInfo), Processing of remote sensing data and satellite images (ERDAS Imaging).

Task Duration: 0.5 month.
Cost Estimate:

Association "Institute of Non-proliferation" will provide a specialized software package ERDAS Imaging 8.3 for implementation of the Project.

##	Expenditures	Price per unit, $	Q-ty	Cost, $
1	GIS Software Package ArcInfo Professional	2500	2 working places	5000
2	ArcInfo Training	850	3 persons	2550
3	Travels (5 days)	1400	3 persons	4200
4	ERDAS Imaging Software package	To be provided by the Institute of Non-proliferation		0
5	ERDAS Imaging Training	750	3 persons	2250
6	Travels (5 days)	1400	3 persons	4200
	Subtotal:			18200

3.0 Mapping of the objects
The objects, which are included into the databases under the Tasks 1.1 и 1.2, will be mapped on the electronic maps with GPS binding. It is proposed to use a specialized software package for creation a Geo Information System "ArcInfo". Several information/thematic layers will be created for different types of objects: oil and gas mining, processing, oil and gas pipelines, control and storage facilities, auxiliary facilities, nuclear objects, uranium and coal mining and processing facilities, dumps and wastes, and other information layers, if necessary.

Task Duration: 1.5 month.
Cost Estimate:

##	Activity / Expenditures	Duration, month	Labor, man/month	Cost, $
1	Adjustment and detailing of the infrastructure at the Caspian region	1	4.25	2380
2	Binding and mapping of the objects	1.5	6.5	3650
3	Vectorization of missing electronic maps	0.5	3.25	1820
4	Electronic maps, topographic maps			8000
	Subtotal:			15850

4.0 Systematization of existent data on radionuclide contamination at the region
At this Task it is proposed to systematize all existent information on radionuclide contamination at the Caspian region. Data on the radionuclide contamination will be mapped. The information/thematic layers on different radionuclides will be created.

Task Duration: 1.5 month.
Cost Estimate:

##	Activity / Expenditures	Duration, month	Labor, man/month	Cost, $
1	Compilation of information on radionuclide contamination	0.5	3.75	2100
2	Entering into computer	0.5	2.75	1540
3	Data processing and Analysis	1.5	4.25	2380
4	Creation of thematic maps	0.5	2.25	1200
	Subtotal:			7220

5.0 Processing and Analysis of satellite images and remote sensing data
To determine and evaluate pattern contamination areas it is proposed to process and analyze satellite images and remote sensing data for the territory of the Caspian region. Processing of images will be conducted using ERDAS Imaging software package. It is proposed to study recognizable features of known contaminants and to map the areas. The results of this Task will be used for the GIS and will be used for creation thematic maps on different types of contaminants at the region, including radionuclide contaminations and oil products contaminations.
The results will be also used as a basis for further modeling and forecasts of the contamination situations at the Caspian region.

Task Duration: 2 month.
Cost Estimate:

##	Activity / Expenditures	Duration, month	Labor, man/month	Cost, $
1	Processing and analysis of satellite images	1.5	7.85	4400
2	Interpretation of data, correlation with field data	0.5	6.2	3400
3	Creation of thematic maps on different contaminants	1	4.25	2400
4	Field expeditions	0.5		8200
5	Satellite images (Landsat TM7)			7500
	Subtotal:			25900

6.0 Classification of objects by risk level

6.1 Correlation of objects-sources with contamination areas

At this Task all data gathered/compiled during the previous Tasks/stages will be analyzed. The correlation between different thematic/information layers will be conducted. As a result of the analysis the correlation between different areas/types of contaminations and objects-sources of radionuclide/oil-related contamination will be worked out.

6.2 Analysis and determination of criteria for objects classification

Classification criteria will be determined. All objects will be classified into groups depending on risk/hazardous level and physical protection issues. The classification criteria of objects will include, but not limited to:

Risk level of technologies used and environmental influence
Quality of final products
Environmental conditions and level of its influence on final products
Level of existent physical protection of objects

Task Duration: 2 month.
Cost Estimate:

##	Activity / Expenditures	Duration, month	Labor, man/month	Cost, $
1	Correlation of data for different objects	1	6.75	3780
2	Determination of criteria for object classification	0.5	5	2800
3	Evaluation objects under criteria /Object Classification	1	6.75	3780
	Subtotal:			10360

7.0 Development of Principal Models of Physical protection systems

At this Task, Principal Models of physical protection for different classification groups will be worked out.

A Principal model shall provide the following:
Control principles
Monitoring methods
Response scenarios
Evaluation of risk level

Task Duration: 3 month.
Cost Estimate:

##	Activity / Expenditures	Duration, month	Labor, man/month	Cost, $
1	Development of Control principles	2	12.2	6800
2	Development of Monitoring methods	2	12.2	6800
3	Development of Response Scenarios	1	7.75	4340
4	Evaluation of Risk levels	1	7.75	4340
5	Elaboration of recommendations for application of Physical protection system at objects	0.5	6.4	3600
	Subtotal:			25880

8.0 Project Proposals development
On the basis of the results of the research project proposals will be worked out and prepared.

Task Duration: 0.5 month.
Cost Estimate: $5000

Total Cost of the Project:

##	Tasks/Stages of the Project	Cost, $
1	Составление базы данных объектов	39170
2	Training	18200
3	Mapping of the objects	15850
4	Systematization of data on radionuclide contamination	7220
5	Processing and analysis of images	25900
6	Classification of objects by risk level	10360
7	Development of principal models	25880
8	Elaboration of Project proposals	5000
9	Reporting and Translation	6500
10	Equipment (3 personal computers, database software – Lotus Notes)	25000
11	Travels	10000
12	Communication	5500
11	Taxes (social tax, income tax and pension assignments)	54770
12	Overheads (10%)	24935
	Total:	274285

Estimation of efficiency of underground waters protection from anthropogenous sources of pollution in process out of operation of industrial waste storage in PJSC “UMP"

1. Duration of the project.

4 month

2. Total cost.

400 000 USD

3. The introduction (the ground and actuality). Location of the project.

Ulba is situated in Ust-Kamenogorsk, Eastern Kazakhstan. It is the center of Rudny Altay . The “birth” of Ulba was connected with the processing of Zinc bearing monazite ores. The first product – Thorium Oxalate – was produced at the facility in September 1949. This date was further considered the date of “Ulba Metallurgical Plant” PJSC foundation. Thorium fuel cycle was not further developed and Thorium Oxalate production was terminated at the facility rather soon.

In January 1951 the facility started to produce Hydrofluoric Acid (HF).

In March 1951 trying out of the sulphate process of Beryllium Hydroxide and Oxide became the starting point of Beryllium production. In January 1956 the commercial processing of ore sorting Beryl concentrates was put into operation and in May the same year – production of high pure Beryllium Oxide.

In 1961 the production of Beryllium as cast and Copper Beryllium Alloys was started. Thus, the complete complex of Beryllium production was created beginning with recovery from the concentrates to production of Hydroxide, technical grade Beryllium as cast , master alloys, alloys, Beryllium billets, semi-products and parts by powder metallurgical process, wrought and cut products, Beryllium Oxide ceramics including a large range of products of wide application.

Commercial production of Tantalum metal and products was established and developed on the basis of local Belogorsk Tantalite mine. Since December 1959 Ulba has been producing Tantalum metal powder and in 1962 the whole Tantalum production was oriented to Tantalum metal powders and ceramics.

Uranium production at Ulba started in 1953 when the facility began to process Uranium ore concentrates to produce natural U3O8 and UF4. The production was further developed , reconstructed and the initial feed and final products changed. In the period when the Government adopted a large scale program for atomic power in the country and the established scientific and technical potential of atomic science and technology was applied in the interests of economics, Uranium production of Ulba was reoriented to low enriched Uranium Dioxide powders and fuel pellets for WWER and RBMK reactors. In 1976 Ulba started to produce fuel pellets for power plants on a commercial scale. In the period 1976-1990 Ulba produced most fuel for reactors constructed in the USSR.

Almost all principal processes of our facility provided for a large amount of process wastes. To arrange storing of hazardous for human health wastes over prolonged time spans Ulba has designed and constructed special waste storages. The waste storages were designed in respect of the amount of potential liquid wastes and the rate of water evaporation from the mirror of the storage. In case of balance of these two streams the waste storage can operate for rather a long time without any need of reconstruction. In such conditions water proofing of the waste storage bottom and persistent water level provide for non-permeability of toxic and radioactive wastes either to water or air .

As soon as the waste storages are not used or the volume of wastes is decreased due to reduction of production capacities any technical measures should be undertaken to preserve the waste storages. In such case both underground water and atmosphere must be protected from process wastes of higher hazard. Generally after reduction of liquid process wastes dumping volume the level of solutions in the waste storages is rapidly reduced too due to natural water evaporation. The “beaches” generated are covered with the sediment containing high toxic and radioactive materials. After drying this sediment undergoes windy erosion and higher dust raising from the “beach” surface can result in higher concentration of hazardous materials in the air. Besides the lack of the water mirror in the waste storage can create such conditions when a low water proofing layer of the waste storage is broken (e.g. the layer can be frozen and cracked with severe frost). Thus, such conditions may occur when atmospheric precipitation may wash out the sediment of the “beach” and toxic or radioactive materials can penetrate into the underground water through the broken water proofing of the waste storage. Obviously that to preserve the waste storage such measures should be undertaken which prevent windy erosion and protect the “beaches” from atmospheric precipitation.

After significant reduction of Ulba production capacities the level of solutions in the waste storages for liquid wastes of hydrometallurgical operation was also reduced. The reduction level is estimated at some meters and the area of the “beaches” generated - at some hectares.

Speed of reducing of level in the waste storage and the results of the analyses of underground waters speak about partial destruction of storage bottom layer and about the raised filtration of industrial wastes to underground waters.

It is necessary to note, that the Ulba waste storage is situated near residential area of Ust-Kamenogorsk city. Distance between storage and the Ulba river is 3,2 kms, and the Irtish river - 5,4 kms. In immediate proximity from storage (3,7-8,2 kms) are situated 3 drinking water springs for the population of city. The underground flow of earth waters by capacity up to 640 thousand м3 per one year proceeds on depth of 9-30 meters under storage. The hit of harmful and radioactive industrial wastes saved in storage to underground waters and further to the Irtish and Ulba rivers and to urban drinking water springs is not excluded in these conditions.

4. The tasks.

The project of interception of underground waters, proceeding under industrial waste storage, is developed for prevention of anthropogenous pollution of water resources. The project includes drilling chinks above than level of storage and pumping of the most part of underground waters on pipelines to Brazhnikov stream, flowing much below than level of waste storage. The project stipulates creation of covering for industrial wastes storage, removed out of operation. The covering should supply reliable isolation both long-term stabilization of harmful and radioactive substances. The construction of the new waste storage with the improved waterproofing of bottom, executed from modern materials is supposed below than level of old storage. Drainage water of storage out of operation, and the part of underground flow will be pumped out through specially drilled holes and to be going to new waste storage.

The realization of the project of interception of underground waters will allow completely exclude pollution of underground waters by harmful and radioactive substances.

5. Objectives of work under the project (stages, participants, the specification of work for each participant).

The estimation of efficiency of the carried out technical measures is the very important component of this large project. Such estimation can be executed by results of the analyses of earth waters before and after end of the project. In this case probable mistakes and the discrepancies in the project can result in its low efficiency and the dangers of pollution of water resources will not remove. The purpose of the offered project is development of mathematical model of a hydro-geological condition of underground waters in area of wastes storage. It is supposed to estimate efficiency of all design decisions on interception of underground waters on the basis of the developed model even prior to the beginning their practical realization. It will help to optimize resources for realization of the project. The model should allow to choose optimum places of interception of underground waters above and below than level of storehouse. Besides on the developed model it will be possible to estimate long-term consequences of realization of the project of interception, to define service life of new wastes storage.

The mathematical model of a condition of underground waters will be created on the basis of results of hydro-geological researches of a wastes storage site. the real data on pollution of earth waters near to storehouses saved for more than 20 years of supervision will be used for model improvement and the specifications.

6. The purposes.

Task 1. *Development of mathematical model of underground waters in area of industrial wastes storage site of Ulba Plant.*

Software and hardware for development of model should be purchase The Ulba Plant experts should pass training in LLNL on development of mathematical models. The approached model of a condition of underground waters in area of storehouse should be constructed on the basis of the given hydro-geological researches. The experts of "Kazatomprom" have wide experience in study of underground waters and will accept direct speed up in development of model. During development of model the experts LLNL will render the consulting help.

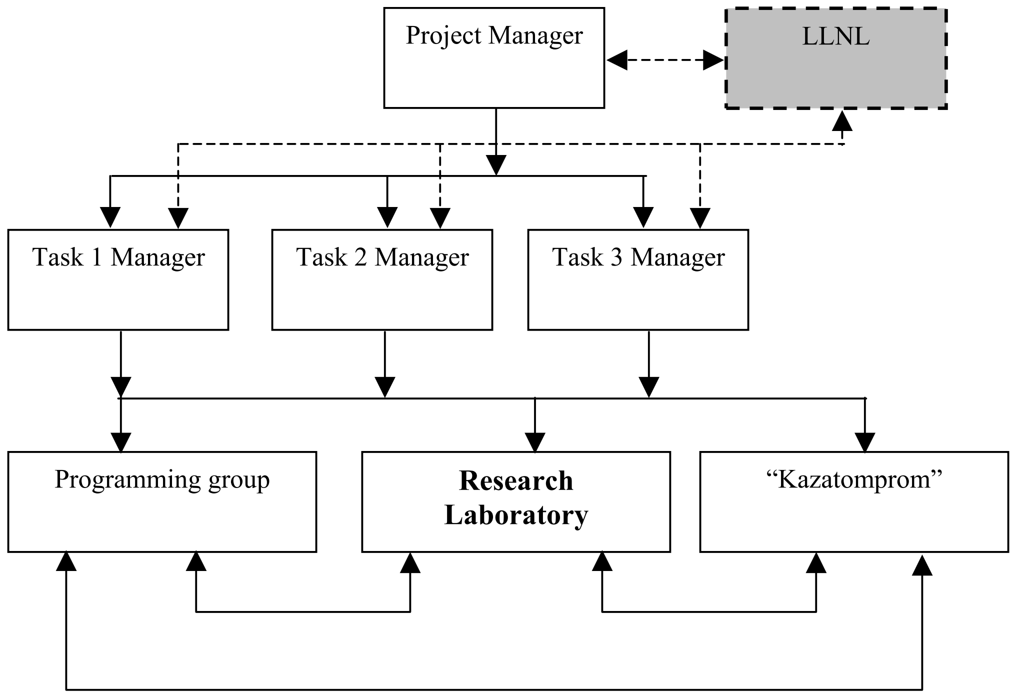
Task 2. *Giving accurate definition to the mathematical model.*

Giving accurate definition of mathematical model, increasing of its adequacy will be carried out by results of long-term hydro-geological supervision spent on Ulba Plant. The LLNL experts will conduct the methodical management of work on accurate definition of model. It is supposed, that after end of this stage of the project the model will describe precisely enough condition of underground waters near to storage site and to predict possible changes in a hydro-geological situation at external influences. The experts Ulba Plant can independently improve the developed model after end of this task.

Task 3. *An estimation of efficiency of withdrawal of industrial wastes storage out of operation.*

Efficiency of the design decisions on realization of measures on a withdrawal of industrial wastes storage out of operation will be forecast. The realization of this stage will allow to choose optimum ways of realization of the project of interception and to minimize pollution of underground waters by anthropogenous wastes.

7. The management of the project.



8. Expected outcomes.

The value of pollution of earth waters after end of realization of the project of their interception will be appreciated on the basis of the created model. The model will be improved and after end of the present project. It is supposed, that the constant specification of model on a basis all new and new data on change of a hydro-geological condition will allow precisely to predict possible pollution of underground waters near to industrial wastes storage and to prevent it in time.

Use of experience, which we shall get during development of mathematical model on the offered project, will help to distribute results of the present work to other projects on a withdrawal of radioactive wastes storages from operation. It is known, that the problem of long-term stabilization of such storages and estimation of efficiency of works on their isolation is global and exists in many countries of the world. The developed principles and methods of construction of hydro-geological model will allow apply results of this work and to other similar storages of industrial radioactive wastes.

9. Inquire of finance (estimate of cost and/or price structure).

Estimated total cost of the project (US$)	**$ 400000**

Including:

Payments to Individual Participants	$ 237000
Equipment	$ 75000
Materials	$ 5000
Other Direct Costs	$ 28000
Travel	$ 35000
Overhead	$ 20000

10. Contribution of the participants, including material and other costs.

Ulba Plant and “Kazatomprom” is ready to carry material and other expenses connected with use of the available research and analytical equipment of laboratories of the plant, expense connected with maintenance of researches by working rooms, energy and other municipal services as the additional contribution to the present project. Ulba Plant will supply the researchers of the project with funds of the scientific and technical library, and also archival materials .

11. Potential role of the foreign participants, including mechanisms and inquire means.

LLNL takes part at all stages of realization of the present project from planning researches up to an estimation of efficiency of results of development. The LLNL experts conduct the analysis of an ecological situation in region of industrial wastes storage together with the scientists from Ulba Plant and “Kazatomprom”. The experts LLNL will render the advisory help in development and use of model at all stages of the project, will carry out training the experts from Kazakhstans to methods of computer modeling. The researchers from Kazakhstans and from USA constantly exchange the information on a course of realization of the project on symposiums and working seminars. The partner will assist the executors of the project in visiting the international meetings, conferences, seminars.

12. Training.

The Ulba Plant experts should pass training in LLNL on development of mathematical models.

13. Requisites for communication . The author of the project (place of work, position, address, phone and fax.

Product Joint-Stock Company " Ulba Metallurgical Plant " (PJSC “UMP”), Kazakhstan

Project Manager - Gagarin Alexandr - chief of the central research laboratory, ph. (7-3232)-298172, fax. (7-3232)-240683, E-mail gagarin@sigma.kz

National Joint-Stock Company "Kazatomprom" (NJSC "Kazatomprom"), Kazakhstan

Project Manager - Duisebayev Baurzhan - head of department of new technologies., ph. (7-3272)-691627 fax. .(7-3272)-503541 , E-mail bduisebayev@kazatomprom.kz

Lawrence Livermore National Laboratory (LLNL) and U. S. Department of Energy, USA

J. H. Richardson, Deputy Program Leader, PPAC Program, richardson6@llnl.gov,

D. K. Smith, Radiochemist, Analytical and Nuclear Chemistry Division, smith24@llnl.gov

A. F. B. Tompson, Hydrologist, Geosciences and Environ. Tech. Division, afbt@llnl.gov

Pre-Workshop Proposals Received (English)

Akhmetov, M.A., Yu.G. Stril'chyk, and M.S. Panin
RK NNC Institute of Radiation Safety and Ecology (RK NNC IRSE), 2 Krasnoarmeiskaya St., 490021 Kurchatov, Kazakhstan, E-mail: irbe@nnc.kz, Telephone/Fax: 8 (322-51) 2-34-13
Shakarim University, Semipalatinsk

Study Of Radionuclide And Heavy Metal Content And Migration In Landscapes Of Degelen Mountain Massif (STS)

Project Duration – 2 years

Total Estimated Cost - $100,000

Problem Statement

By now, the processes of interaction between radioactive fallout and soil-vegetation cover, such phenomena as sorption and fixation stability of many man-made and natural radionuclides, regularities of radionuclide accumulation by living organisms and radionuclide transport through the food chain depending upon ecological and physical and chemical factors have been very often addressed and are quite well studied. However, these studies were conducted in areas either with the background radiation levels or low contaminated. Besides, these studies were mainly carried out in areas contaminated due to activities other than underground nuclear testing, often using simulating facilities where the activity of radionuclides added was limited and the study duration was short.

The Degelen mountain massif located at the former Semipalatinsk test site (STS) provides an opportunity to study the above processes, phenomena and regularities under the real conditions created in the period of time comparable to the problem of the environment contamination due to nuclear testing. Radionuclides introduced by water currents are in their easy-to-available form and react with the environment. Their content in water and soil is that high that it could be classified as radioactive waste.

Nobody has ever studied heavy metals content in landscapes of the massif and their interaction with radionuclides under the present conditions.

Project Objective:

To study biogeochemical regularities of heavy metals (HM) and radionuclides (RN) content, distribution and migration in anthropogenic landscapes of the Degelen mountain massif.

Main Tasks:

1. Investigate the total content and types of compounds (water-soluble, exchangeable, organic-bound, combined with sesquialteral oxides and iron hydroxides, combined with carbonates) of heavy metals (copper, zinc, lead, cadmium, chrome, beryllium, cobalt, arsenic, etc.) and the ones of radionuclides (cesium-137, strontium-90, plutonium-239,240) in soil and rock of the massif.
2. Study regularities of the above HM&RN behavior and migration depending upon soil physical and chemical properties (organic content, pH, silt fraction, carbonates content, absorption capacity), texture, and genetic layers.

3. Study content and migration patterns of HM&RN ionic and suspended forms present in water flows and water sources of the massif.
4. Study the correlation dependence between HM&RN content in water and water physical and chemical properties and parameters (pH, salinity, suspended matter, cationic-anionic composition) and determine the interaction between HMs and the one between HMs and RNs and their interdependence in the water-bottom sediment-aquatic life system as well.
5. Determine content of HM&RN compounds in bottom sediment.
6. Estimate HM&RN total content and HM&RN mobile forms present in soil.
7. Determine HM&RN content in aquatic life.
8. Study HM&RN content in wild plants depending upon their species and systematic and morphological features.
9. Identify dependence of HM&RN content in plants on their compound forms in soil.
10. Create a databank of present HM&RN concentrations in environmental objects of the Degelen mountain massif (soil, vegetation, and water) to be used for organizing and further improvement of monitoring.
11. Carry out biogeochemical mapping of the soil-vegetation cover depending upon HM&RN content.
12. Assess the anthropogenic landscapes of the Degelen mountain massif in terms of ecology, biology and chemistry.
13. Elaborate practical recommendations on readjustment of the territory under study.

Ways to Solve Tasks Set Forth

To implement the above tasks it is proposed to analyze soil depth profiles for total HM&RN content and for HM compound forms. This will include analysis of samples taken to the depth of 0-5, 5-10, and 10-15 cm, samples of different plant species, water samples and bottom sediment samples collected from the source, middle and the end of a water stream.

Locations for sampling soil and plants will be selected using soil and plant maps of the area under study.

Methodical guidelines and instructions accepted by the Republic of Kazakhstan standards will be applied during collection, storage, transportation and pretreatment of soil, plant, water and sediment samples for analysis.

Routine analytical methods will be used to determine HM content in the environmental samples, to include:

- chemical methods;
- atomic-emissive spectrographic methods using DGP-50 arc argon double-jet plasmatron;
- absorption;
- X-ray and mass spectrometry methods.

Radionuclides will be determined using the following methods:

- gamma spectrometry;
- radiochemistry.

Data obtained will be processed using the following methods:

- comparative-geographic;
- comparative-analytical;
- mathematical-statistical.

Standard variational statistical mathematical methods will be used to estimate the experimental material and main ecological and beogeochemical parameters (accumulation factors, enrichment factors, risk factors, hazard factors, etc.).

Expected Results:

For the first time a multipurpose ecological-biogeochemical study will be implemented in the area of the Degelen mountain massif. For the first time previously unknown information about this complex technogenic region will be obtained and published.

Scientific baselines for biogeochemical monitoring of the environment in the region of concern will be laid down. They will be of high practical importance as they will assist in developing a strategy for effective nature management and improvement of the biogeochemical monitoring.

To work out scientific problems related to the extreme ecology is of great importance in terms of sustainability and stability of ecosystems under impact of regional anthropogenic activities.

Management

The project will be implemented under the leadership of the RK NNC Institute of Radiation Safety and Ecology.

Estimated Project Costs (in US$)

Equipment	10000
Field and analytical work	20000
Payments to individual participants	40000
Oil & lubrication	20000
Services	5000
Other costs	5000

Contributions made by Participating Institutions

RK NNC IRSE: field work, gamma spectrometry and radiochemistry analyses, estimates, recommendations.

Shakarim University: analysis of environmental samples for HM content.

Potential Role of American Partners

- Determination of the study program;
- Discussion of reporting documents;
- Assistance in the study planning and implementing.

Artemev, O.I. , L.D. Ptitskaya, and Yu.G. Stril'chuk
RK NNC Institute of Radiation Safety and Ecology (RK NNC IRSE), 2 Krasnoarmeiskaya St., 490021 Kurchatov, Kazakhstan, E-mail: irbe@nnc.kz, Telephone/Fax: 8 (322-51) 2-34-13

Study Of Radionuclides And Their Forms Present In Bottom Sediment Of Closed Water Bodies At Former Semipalatinsk Test Site

Project Duration – 3 years

Total Estimated Cost - $200,000

Problem Statement

By now, detailed radioecological studies have only covered ~30% of the Semipalatinsk test site (STS) territory. The studied areas are mainly located within the test site but off the radioactive plume footprints and considerably far from the STS technical areas used for aboveground testing. These studies basically included collection and analysis of samples of soil-vegetative cover. But no one of several tens of natural lakes located at the test site was investigated. However, bottom sediments of these lakes differently remote from the areas of aboveground nuclear testing may contain information about deposition of radioactive particles from the post-explosion radioactive plume. Bottom sediments accumulate radioactive substances deposited from the atmosphere, washed down from the land surfaces and due to resuspension. As the bottom sediment experiences no anthropogenic influence, it is a unique storage of information about atmospheric nuclear tests made at the STS.

Studying the distribution of insoluble fraction of the radioactive substances in the bottom sediment of the water bodies will make it possible to identify nuclear tests which caused the associated radioactive fallout and to quantify them depending upon the distance from the ground zero.

Project Objective:

To study nuclear-physical and physical-chemical features of radionuclide accumulation, distribution and migration in the bottom sediment of the natural water bodies at the Semipalatinsk test site.

Main Tasks:

14. Select hydrological objects (natural lakes) for study based on available information about conduct of aboveground nuclear tests. Collect samples of bottom sediment, water and soil.
15. Determine radionuclide (cesium-137, strontiumm-90 and plutonium-239,240) content in bottom sediment of lakes and in soil of lake catchment areas. Determine radionuclide content in different soil fractions.
16. Study regularities of radionuclide distribution and migration in the bottom sediment depending upon the radionuclide forms (magnetic and non-magnetic radioactive particles, their solubility, etc.) and soil physical and chemical properties (organic content, silt fraction, pH, content of carbonates and sulfates, absorption capacity).

17. Study correlation dependence of radionuclide content in the sediment on radionuclide content in soil near the water body and in the water itself. Estimate the amount of radionuclides introduced into the water body directly from the radioactive plume and indirectly due to radionuclide transport.
18. Determine content of insoluble radioactive particles in bottom sediment and their distribution over sedimentary layers in order to identify nuclear tests by the year of conduct.
19. Calculate ratios of different radionuclides in analyzed soil and sediment samples.
20. Create a data bank of radionuclide concentrations in aquatic objects of the Semipalatinsk test site (water and bottom sediment) to be used for organizing and further improvement of monitoring activities.

Ways to Solve Tasks Set Forth

By now, detailed radioecological studies have only covered ~30% of the Semipalatinsk test site (STS) territory. The studied areas are mainly located within the test site but off the radioactive plume footprints and considerably far from the STS technical areas used for aboveground testing. These studies basically included collection and analysis of samples of soil-vegetative cover. But no one of several tens of natural lakes located at the test site was investigated. However, bottom sediments of these lakes differently remote from the areas of aboveground nuclear testing may contain information about deposition of radioactive particles from the post-explosion radioactive plume. Bottom sediments accumulate radioactive substances deposited from the atmosphere, washed down from the land surfaces and due to resuspension. As the bottom sediment experiences no anthropogenic influence, it is a unique storage of information about atmospheric nuclear tests made at the STS.

Studying the distribution of insoluble fraction of the radioactive substances in the bottom sediment of the water bodies will make it possible to identify nuclear tests which caused the associated radioactive fallout and to quantify them depending upon the distance from the ground zero.

To solve tasks specified above it is proposed to investigate bottom sediment of water bodies, water and soil form the catchment areas located both within and outside the radioactive plume footprints. Collected samples of soil and sediment will be analyzed for total radionuclide content and for radionuclide distribution over the sediment depth profile as well as for radionuclide content in different soil fractions. Samples collected will also be analyzed for chemical composition.

Topographic maps of the test site territory will be used to select study objects. These maps also contain the information about the radiation situation in the area of concern based on data of aerial gamma survey.

Methodical guidelines and instructions accepted by the Republic of Kazakhstan standards will be applied during collection, storage, transportation and pretreatment of soil, plant, water and sediment samples for laboratory analysis.

The following methods will be used to determine radionuclide content in the environmental objects:

- gamma spectral;
- radiochemical;

according to procedures certified in the Republic of Kazakhstan.

Expected Results:

For the first time a multipurpose study of water bodies (lakes) will be implemented at the Semipalatinsk test site. For the first time previously unknown information about radionuclide deposition, migration and accumulation in aquatic environment due to aboveground nuclear tests will be obtained and published.

Scientific baselines for the radiation monitoring of the environment in the region of concern will be laid down based on study of bottom sediment from the natural water bodies which are a unique storage of information about nuclear tests. It will be of high practical importance for development of a strategy for effective nature management. Working out scientific problems related to radioecology is of great importance in terms of sustainability and stability of natural ecosystems.

Management

The project will be implemented under the leadership of the RK NNC Institute of Radiation Safety and Ecology.

Estimated Project Costs (in US$)

Equipment	20000
Field and analytical work	40000
Payments to individual participants	80000
Oil and lubricants	40000
Services	10000
Other costs	10000

Contributions made by Participating Institutions

RK NNC IRSE: field work, gamma spectrometry and radiochemistry, estimations, recommendations.

Potential Role of American Partners

- Determination of the study program;
- Discussion of reporting documents;
- Assistance in the study planning and implementing.

Arystanbayev, Ya. (a)

1. Development of criteria and input dates for burial of radioactivity waste from oil fields in Caspian regions on common square of 3370 sq. km.

2. Introduction.

The problem is pollution of environment and process equipments during oil producing natural radionuclides - uranium, radium and thorium which concentrations exceed natural background radiation tens and hundreds times. The radioecological operations, which have been spent "Volkovgeologia" in 1992-1997ies in Western Kazakhstan, have revealed technogeneseous of radiocontamination on sites of oil field operations in Mangistay and Atyray areas. Objects of radioecological researches were the sites of separate and group deposits of oil and gas in territories of activity of joint-stock companies "Mangistaumunaygas", "Embamunaygas", "Tengismunaygas" and "Usenmunaygas " (fig. 1). Main method of radioecological researches was aerogamma- spectrometer survey attached to the plane АН-2 or helicopter МИ-8, scale research was 1:10000 in 1992-1997ies. The six-year researches covered 53 deposits on 31 sites of operations on common square 3370 sq. km., in Western Kazakhstan, thus 275 radiocontaminates sites requiring deactivation are detected.

So, as a result, radioecological researches clearly show scope of problem connected with technogenous of radiocontaminations bound with industrial waste.

In connection with planned commissioning of new objects and increase of mining on operating deposits of oil at the existing "know-how" it is necessary to expect twofold size of radioactive waste and increase of the polluted areas. Therefore the problem of rehabilitation of territories with radiocontamination and burial of radioactive waste is rather actual and acute today.

3.Aims and tasks.

The Concept of localization of radioactive wastes was designed at 1992-1997 in the Republic of Kazakhstan, that proposed the system of radioactive waste storage and of waste management with support of radiation safety. The creation of any of elements of system requires studying and developing the complex of questions and tasks:

■ To improve a position and contour of sites of a radiocontamination on topography basis, to study them on depth of penetration. The investigation is carried out with detailed radiometric surveys and drilling small pit-holes (up to 1m) and sampling them on intervals.

■ To study the physicochemical characteristics of wastes, which consist of:

- Radionuclide composition, concentration of natural radionuclides and other toxic chemical elements , size and weight of polluted soil, metal and process equipment subject to a burial;

-Studying hydro-geological, geochemical and other factors influenced on distribution of radionuclides on laterale and vertical;

-Choice of concrete places and types of a burial of wastes;

-Solution of questions of monitoring a state of underground waters with drilling of hydro-geological wells up to a surface of first aquifer.

It will needs carrying out of complex of operations for solutions of the tasks that include:

-Collection, analysis and generalization of materials on radioecology within investigated territory;

-Collection, analysis and generalization of materials on geology, hydrogeology and landscape of the same territory
-Carrying out of field operations for detailing outlines of sites of radiocontamination, learning them on depth and field researches of other parameters.
The similar operations have spent by the ecological group of "Volkhovgeologia" on restricted square of oil field of joint-stock company "Usenmunaygas". The obtained date testify increase of amount and common square of radiocontaminated sites as contrasted to 1994, when the aerogamma-. spectrometer survey in the scale 1:10000 was spent, the cost of the operations were improved in the course of ones.

4. Total cost.
The total cost of the operations is determined on the basis of experience of operations on oil of square fields of joint stock company "Usenmunaigas".
On the average, cost of researches on 100 square km is 1.2million tenge, switching the VAT. The total cost of the project will is:
1.2 million tenge x(3370km^2 -700km^2)=32.0 million tenge or 220 thousand US dollars.

5. Finance
The individual share in financing the project of the foreign investors (USA) and Joint Stock companies, in which territory the researches will be carried out can be offered.

6. Contribution of the participants joint stock company "Volkovgeologia":
Collection, analysis and generalization of available materials;
Carrying out field operations for specifying the current radioactive state of territories;
Sampling grounds, water and plants;
Analytical operations;
Drawing and framing of reports, development of recommendations and conclusions.

Subcontract organizations (for each joint stock company):
Drilling hydro-geological wells for monitoring the state of underground waters.
The foreign investors:
The possible help in support of a modern hardware part for carrying out of field operations (dosimeters, definition of radon in water and ground, navigation instrumentation GPS compatible with computers etc);
Implantation of newest western techniques for carrying out analogous operations (as field as modern techniques of information processing):
Framing of some guidelines and conclusions.

7. Expected results.

For each oil field, covered by researches, it will be executed:
Specifying a modern radioactive state with compilation of maps and a catalogue of radiocontaminated sites;
Determining of radiocontaminated sites with compilation of the detailed passports for each radiocontaminated sites subjected to disactivity;

Specifying some variants of a possible place of the burial for metal wastes and radioactive contaminated soil;
Developing the guidelines for the choice of the optimal network of observational points of the regime network for carrying out complex monitoring behind a state of the natural environment and underground waters.
The obtained results will be input date for designing and construction of a burial of radioactive wastes.

8. Coordinate for link

Telephone 92-60-17; 92-68-14
Facs 50-13-59
E-mail: volkgeo@nursat.kz; kge39@aport2000.ru
"Volkovgeologia"
Bgenbai Batyr Str., 184
Almaty 480012
Kazakhstan

Arystanbaev, Ja.Y. (b)

The learning sorptive - capacity properties in laboratory conditions and experimental - industrial trials of natural zeolite, as a filtrate on clearing underground waters polluted by radionuclides

3. Duration of the project - 2 years

4. **Total cost** - 195 thousand $US, including:
4.1. Cost of execution of the analyses on definition of sorptive capacity of natural zeolites - 5,5 x 5 = 27,5 thousand $ USA
4.2. Cost of manufacture, installation and service of prototype of block filter apparatus with productivity 20-50 m^3 / hour.
150 thousand $ USA
Laboratory researches - 10 tests - 5,5 thousand $ USA
Compilation of the feasibility report of the overall performance of block filter apparatus with natural zeolites - 10 thousand $ USA.

Definition of the problem including history and location

The base of the project is the results of the radio ecologicol investigation: hydrogeochemical researches fulfilled by “Volkovgeologia” and operations spent on contract №9116/PB with IAEA (B.R. Bericbolov, J. Nicolet)

The Cretaceous - Paleogen aquifer, in Shu-Sarysu artesian basin contain mainly fresh underground waters under high pressure head and are the unique source of water supply for the population in Suzak district of the South-Kazakhstan area. Natural resources of fresh underground waters with total dissolved solution up to 1 g/l of the basin only for Cretaceous-Paleogene water bearing complex are estimated in size 365,8 milliard m^3. Reasonably assured resources of underground waters for industrial and drinking water supply and irrigations of grounds within the basin ore more 300-thousand m^3/twenty. The resources affirmed by the State regional commission on natural resources in USSR.

It is well-known that Shu-Sarysu uranium province contains industrial uranium deposits: Kahzhugan, Moyinkum, Tortkuduk, Kaynar in Paleogene depositions, Yvanas, Akdala, Mynkydyk, Inkai, Bydennovskoe in Cretaceous derivations, where intently to 25 % of global resources of uranium ores concentrated. The industrial extraction of uranium from some the deposits - Kahghugan, Moyinkum, Uvanas, Akdala, Mynkydyk with sulphate is leaching is carried out by some mine groups of NAC “KAZATOMPROM” now .

The researches within Shu-Sarysu uranium province is authentically detemined, that natural above permitted standard radionuclide pollution of Cretaceous- Paleogene aquifers spreads to considerable distances from control ore zones of the bedded oxidation. For the underground waters the absence of the high content of uranium (average concentration 5,8mg/dm^3) and complete absence of Ra-228 (aprogeny of thorium -232) is as usual. The main contribution in 25 times exceeds to an effective dose is created by Ra-226, its volumetric activity equilibrium value with uranium; the coefficients of equilibrium of Pb-210 and Ro-210 accordingly make 10 and 2.

An actual problem in conditions of Kazakhstan is clearing against natural or technogenous radionuclide pollution should be carried out for waters from ore-bearing aquifers.

Central Scientific Researches Laboratory of “Volkovgeologia” fulfilled laborotary-analytical researches on definition of sorption-capacity of not oxidated barren sand (3 tests) and natural zeolite from Sary Ozek deposit (6 tests) as possible purifying agents against radionuclides.

In the following tables the results of these researches with definition of sorptive coefficient, are given according to the ratio with the most toxiferous radionuclides - Po-210, Pb-210.

Table . **Sorptive coefficients of sand and zeolite for Po-210 and Pb-210**

<table>
<tr><td>№ samples</td><td>Total Mass of samples, g</td><td colspan="2">Content of radioactive Isotops before | after an experience, Bk|kg</td><td colspan="2">Sorptive coefficients, Bk\kg</td></tr>
<tr><td colspan="6">Sand</td></tr>
<tr><td>5-1/1</td><td>649,4
169,67</td><td>75,15/11
75,15/119</td><td>140,33/350
140,33/310</td><td>41,8
43,8</td><td>209,7
169,7</td></tr>
<tr><td>5-2/2</td><td>-</td><td>-</td><td>-</td><td>42,8</td><td>189,7</td></tr>
<tr><td>Average</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Zeolite</td></tr>
<tr><td>6-2/1</td><td>102,39</td><td>10/530</td><td>25/4080</td><td>540</td><td>4055</td></tr>
<tr><td>6-2/2</td><td>95,58</td><td>10/86</td><td>25/115</td><td>76</td><td>90</td></tr>
<tr><td>6-2/3</td><td>158,96</td><td>10/25</td><td>25/25</td><td>-</td><td>-</td></tr>
<tr><td>6-2/4</td><td>193,65</td><td>1-/25</td><td>25/25</td><td>-</td><td>-</td></tr>
<tr><td>For column</td><td>-</td><td>-</td><td>-</td><td>123,2</td><td>769,6</td></tr>
</table>

The tables show, that sorptive capacity of natural zeolite approximately five times more than sorptive capacity of sand.

6. Purpose of the project

“ Laboratory researches and experimental - industrial trials of natural zeolite as sorbent of radionuclides “ with compilation of technological - economic justification (FEASIBILITY REPORT) far the efficiency of application of the apparatus.

7. Description of the tasks.

7.1. Studying sorptive-capacity of natural zeolite in laboratory conditions as possible purifying agent of fresh underground waters against radionuclides and other toxiferous elements.

7.2. Manufacture of prototype of block filter apparatus with productivity 20-50m^3/hour

7.3. Trial of experienced apparatus in natural conditions (deposit Kanzhygan)

7.4. Compilation of the feasibility REPORT of an overall performance of block filter apparatus and output of the guideline

8. Management of the project

Organization of a special group of the performers:
The experienced engineer - hydrogeologist -1 man.
Engineering-hydrogeologistes -2 man
The engineer - technologist -1 man
The chemist - laboratory assistant -1 man

Total: 5 man

9. Expected results

As a result of laboratory-analytical researches sorptive capacity of natural zeolites will be fulfilled through some field researches with development of trial apparatus on clearing against radionuclides; the feasibility REPORT of implantation in to production of the apparatus will be made.

10. Financing the project

At the expense of the investors - 70 % of the total cost
At the expense of own resources and other funds - 30 % of the total cost

11. Central Scientific Researches Laboratory of "Volkovgeologia" contribution of the participants, including material and other expenditures, Livermol National Laboratory of USA - laboratory sorptive - analytical operations on learning sorptive capacity of natural zeolites and waters treated against radionuclides.
"Volkovgeologia" - mounting and service of the trial block filter apparatus.
Investor: financing of all complex with it taking into consideration of manufacture of trial block filter installation and subsequent field tests.

12. Potential role of the American partners

Mutual exchange of practical experience and scientifically technical information in solution of some questions.

Selection of the investors for practical implementation of the tasks.

Kayukov P.G.

"Definition of features of a geological hydro-geological section for the characteristic of paths of radionuclides migration."

3. **Duration of the project**
2 years

4. **Total cost**
$ 200 000

5. Determination of the problem including history and location

The learning of distribution or allocation of radionuclides in side and outside uranium deposits in full during carrying out prospecting exploratory operations is fulfilled. Considerable researches on their ecological estimation (Bericbolov B.R. etc 1998) have been undertaken recently for aquifer of these deposits, especially, Kanzhugan, Moyinkum, and Tortkuduk. The results of preliminary researches show that there is a geochemical zoning directed across a frontal zone of a bedded oxidation on these deposits. Within this zoning, the area of heightened values of radium –226 spreads round surrounding all ore deposits and the width of the zone reaches 5-6 kms. During main creation of oxidation zones generated uranium mineralization - at the end of Oligocene and primarily in Miocene - the motion of uraniferous waters occured mainly from east to west (Petrov N.N., 1998г). Thus the zones were the same ones in Shy-Sarysu and Syr-Darya depressions, which tearing up had been taken place in Late Orogenic period (in main, in Quaternary time). As a the flow result, the direction, of underground waters was gradually reverted to the North, and at the present time it practically on all its extent becomes domination for these deposits. Thus interface of modern show of underground waters and the direction of extension of separate ore bodies varies from 0 up to 90 %. And it is especially important to mark that when the direction of modern stream of underground waters coincides with main extension of area of heightened values of radionuclides, that it should be considered as a favourable factor at processing ore bodies by in-situ leaching. In a case when the direction of underground waters directs to the side of a reduction zone at processing a deposit, it can cause casting-off of a part of aquifer suitable for drinking water supply.

Considering all possible geology - hydrogeological conditions, it be necessary to study in more details extreme ones:

1) Ancient oxidised fronts that have formed ore bodies in the same geochemical zonality till now.

2) Ancient oxidised fronts that have been destroyed now.

3) The young oxidised fronts that have formed new ore bodies.

Thus it is necessary to pay attention to a number of circumstances at the formation of ore bodies:

1) The front of bedding oxidation is not always accompanied by the formation of ore bodies

2) Radium haloes present not only in back parts of uranium rolls but also in fronts of parts of ones

Naturally the migration of radionuclides in all these conditions will be depending on a number of properties of the environment and manifestation of composite physical processes such as every possible physicochemical responses, dissolution a crystallization (precipitation), sorption, desorption, lixiviation, emanation etc.

The radium is the most widespread radioelement, that concentrations in underground waters of uranium deposits exceed the permissible value most frequently. From others ones most important should be marked Pb-210, Po-210, Th-230.

The serious attention at leaching of radium and its

isotopes is rendered to mineralization composition and salt content of a solution. The higher salt content in a solution higeher concentration of radium is in the solution. Paying attention to leaching of the radium cations, defining micro and

microcomponent composition of waters allocates in the following decreasing order (Staric E.I. and others 1969,Tokarev A.N. and others 1975)

$Ba^{2+}>Pb^{2+}>Sr^{2+}>Ca^{2+}>K^{+}>Na^{+}$ It is visible that this order goes due to the chemical affinity of these compounds to radium. The similar order for anions looks like CI-> HCO3> $SO42^{-}$. The influence of anions appears through solubility of appropriate compounds.

In real hydro-geological conditions, when the salt content varies

from 0,3 up to 1г/л, the influence of salt composition in solution and value of concentrations of radionuclides in waters is visible. It should be noticed the role of a colloidal component of aqueous solutions was earlier underrated. The last mineral-petrographic researches of Vyatchenikova L.S. (Kayhkov P.G. and others 2000) show importance of studying authigenic fine-dispersions alumosilicagel in systems of rock and aqueous medium.

About what and how it is transferred, it is possible to judge it on radionuclide composition of radiocontaminations close to effusived artesian wells in the aforementioned regions where again it is dominating.The comparison of radionuclides of these pollution has not spent yet depending on the media from which they were washed out. Studying quality of the media and concentrations of radionuclides in an aqueous fluid of this media have not been carried out yet. All these researches also are offered to be fulfilled within the framework of this project.

6. Purpose:

To estimate the favourable and negative factors at possible processing of ore bodies by is-leaching for characteristic types of ore bodies, particular on a modern position of "ancient" and modern zones of a bedded oxidation.

7. Description of the tasks:

1. To specify a modern position of "ancient" and modern zones of a bedded oxidation for a number of uranium deposits (Kanzhugan, Mynkuduk, Tortkuduk etc) and on site Kainar a basis of paleogeomorphological patterns and geology- of hydro-geological materials.

2. To determine migration ability of radionuclides - radium, polonium - 210, lead-210, thorium - 230 and uranium - in different geologic conditions viewing of classification of a position of oxidised zones (in item 1) on the basis of comparison of date for radionuclide composition and contents in pollution near to artesian wells and geology-hydro-geological characteristics.

3. To determine main sorption properties of the geology-geophysical media in frontal parts of ore deposits by studying materials from geological fond and field checking them at drilling restricted number of wells

8. The project management.

The project will be carried out group of 5 experts: 1geologist, 1 hydrogeologist, 1 geophysicits, 1 petrograph and 1 mineralog. For execution of requirement specifications will be involved 3 engineers of a geologic speciality. The drilling will be carried out one of groups of Joint Stock Company "Volkovgeologia". The analytical researches will be fulfilled by Central Scientific Research Laboratory of "Volkovgeologia" and laboratory "Kazhydrochemgeo"

9. Expected results

The reaching of the tasks will allow of leading new research in the ecological estimation of the projects on exploration and mining of uranium by leaching more purposefully.

10. Financing (estimate of expenditures)

At the expense of the investors (50 %)

At the expense of the own contribution (50 %)

11. Contribution of the participants, including material and other expenditures

Proposal species and volumes of works

1) Collection and generalization of some geologic and hydro-geological materials, their analysis and estimation with choice of sites for field researches and specifying technique for execution - 20 man –months – will be fullfilled

2) Field researches in selected sites (their amount is expected not less than 10) will be made with sampling each site not less than 20 sampling of soils for radionuclides, grancomposition and petrography analysis and 10 samples of water for radionuclides. Besides, on each site the number of physical observations and measurements inaccordance with 40 man month will be fulfilled.

3) Laboratory analytically-petrographic research of samples -20 man month

4) Processing the field and laboratory information, execution of comparisons of new and expected date – 20 man month

5) Compilation of the report -10 man month.

TOTAL expenditures are-130 man month.

The salary is of - 35 %

Technical expenditures are of - 35 %

Social payments and other expenditures are of 30 %

Common expenditures in money terms are $100000

12. Potential role of the American partners

Rendering of the methodical help in improvement of the tasks, purposes of spent researches. Rendering of the technical help, if at reaching the improved tasks and purposes more perfect engineering is required, which can be put by the partners.

13. **Other information (if necessary)**

The literature:

1 Berikbolov B.R., Kayukov P.G., Morozko V.B., Punkov A.Ю., Yudin S.S "Definition of levels of radioactive and chemical pollution of underground waters on developning measurements for clearing polluted water in regions with uranium depotision." .

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3 Petrov N.N. "Epigenetic bedded-infiltration uranium deposits of Kazakhstan." -In Geology of Kazakhstan №2, 1998.
4 Starik I.E. "Fundamentals of radiochemistry." -L., Science, 1969
5 Tokarev A.N., Kutcel E.N., Popova T.P. The radiohydro-geological method of reaches in uranium deposits." -M., Sciens, 1975.

Melent'ev, M.I., Yu.A. Grinshtein, and B.I. Kislyi

Radionuclide contamination of Underground Waters of Balapan Ground in the Semipalatinsk Nuclear Test Site

Contact Requisites: Tel.: (8-3272) 46-99-02
Tel./Fax: (8-3272) 46-99-56
Email: igr@kaskelen.almaty.kz

Project Duration: 3 years (36 month)

Estimated Total Cost of the Project: 700 000 (US$)

Project Background

About 470 nuclear explosions have been taking place in the Semipalatinsk Nuclear Test Site (SNTS) territory for 40 years, more then 100 of them were exploded in the bore-holes within Balapan ground at 400-600 m's depth.

A range of organizations conducted radioecological investigations of this site with a view of studying the level of technogenic radionuclide contamination of the day surface, mainly. Thus, aerial geophysical spectrometric survey on the scale of 1:25 000, enlarged subsequently to the scale of 1:12 500 (the JSC «Altyngeo»), and surface lithochemical sampling on the scale of 1:50 000 (JSC «TsentrKazGeologiya») were carried out there in 1992. These works ascertained average density of ^{137}Cs contamination to be 0.15 Cu/km^2). Local anomalies with high level of contamination (up to 4-5 Cu/km^2) coincide with the mouths of blast-holes.

The Institute of Geophysical Researches, NNC RK, along with the Almaty branch of the Institute of Atomic Energy have been engaged in investigation of underground nuclear explosion effect on the environment, technogenic radionuclide migration and spatial distribution in Balapan ground for several years (1996 to 1999). These investigations were conducted within the framework of ISTC K-056-96 project "A Simulation of Contaminant Migration in Underground Water at the Semipalatinsk Nuclear Testing Site". This project was drawn up aimed to "create simulators to forecast radiocontaminant composition quantitatively and qualitatively in given place and time". Based on the database created and a few complex of in-situ geological geophysical and geochemical investigations, the 3D-temporal simulator of radiocontaminant migration was elaborated, where the intensity of rock destruction connected with number and power of nuclear explosions was adopted as the main factor determining migration velocity.

Practical evaluation of the degree of rock massif contamination by technogenic radionuclides was brought about by the results of gamma-ray logging being conducted in the bore-holes of every possible types: blast, observational, instrumental, structural, hydrogeological ones, etc. This work was carried out with the help of serial instrumentation running in integral regime – i.e. only exposure rate (ER) was measured (μR/h). No findings about isotope composition of gamma-emitters were gained in the course of this work.

Analysis of gamma-ray logging materials has revealed the substantially contradictory pattern of the character of gamma-emitting radionuclide distribution comparing with the data on the developed model. It is just explained by the fact that the peculiarities of Ground geological structure, the geometry of rupture dislocations especially, were not taken into account while elaborating the model. The latter seems to affect substantially the process of technogenic radionuclide migration. Thus, one ascertained as a result of archive findings analysis that, a blast-hole and a control bore-hole being located along the same tectonic zone, increased values of gamma-ray background are sensed 3-4 km distant, even a single measuring having been conducted. The other cases, when a tectonic dislocation takes place between blast-holes and observantional bore-holes, do not show gamma-ray background change even within the nearest surrounding of the blast-hole (0.5-0.7 km) nevertheless a range of underground explosions might have taken place there.

It's out of doubt that without knowing isotopic composition of gamma-emitters one can not unambiguously conclude on the results of the anomalies revealed, because small concentrations of ^{137}Cs are undetectable in the integral regime. Simultaneously, we reserve the right of measurement errors and probable errors while drill-core documenting.

Thus, based on the stated above, it is evident that in order to improve the model having been developed within the framework of K-056-96 project and to forecast reasonably ecological situation in the region under investigation one must obtain findings on actual distribution of technogenic radionuclides along sections of the bore-holes available for logging investigations at present.

It's necessary to note that under the agreement between the USA Ministry of Defence and the RK Ministry of Science-Academy of Science of October 3, 1995 on annihilation of the infrastructure of mass destruction weapon, the nuclear weapon infrastructure has been eliminated in the SNTS. The majority of the bore-holes intended for investigation carrying-out are not accessible at present as a result. That is why, special drilling work to allow access of logging equipment to the bore-holes is envisaged by the Project.

Goal of the Project

The goal of the Project is investigating technogenic radionuclide distribution in rock bulk of the Balapan ground, determining the level of underground water radiocontamination, evaluating and forecasting radioecological situation in the area under investigation.

Description of the Tasks

1. To revise the SNTS bore-hole fund, at first visually – i.e. to ascertain which bore-holes are still present in the place, and then instrumentally – i.e. to make an attempt of gauging of the bore-holes found my means of logging.

2. To select several (3-4) local plots for further investigation characterised by different geological conditions. These plots should be the reference ones while studying the influence of geological structure on the process of technogenic radionuclide migration.

3. To clean out the shafts of the bore-holes failed being gauged.

4. To conduct spectrometric gamma-ray logging (SGRL) and to ascertain ^{137}Cs distribution along the bore-holes.

5. ^{137}Cs being ascertained in the bore-holes by SGRL, one needs to proceed with hydrogeological investigations, i.e. to determine the sites of water inflow/outflow, to set the filters, to find the velocity of groundwater circulation, to sample water assays and make their laboratory analysis for ^{137}Cs and ^{90}Sr.

6. To make comparison of ^{137}Cs content of main occurrence and water medium. This relation varying from one bore-hole to another out of the range of permitted statistical errors, one needs to find out the nature of the phenomenon.

7. Materials being accumulated, analysis of caesium spatial distribution in main occurrence and water medium will be conducted resulted in the consistent pattern of this distribution depending on the geological structure peculiarities of the plot under investigation.

8. To refine geological structure of the reference sites one should carry out their large-scale geological survey (1:5000 – 1:10000) accompanied by geophysical methods aimed to ascertain locus and scales of all tectonic dislocations and interrelation of the rocks building up the site.

9. The obtained materials will make it possible to construct several reference simulators to make prognosis assessment of georadioecological situation within the selected areas based on the data on geological structure of these sites and the scales of nuclear weapon test that had taken place there.

10. To make measurements along bore-hole sections of the test sites and to find actual ^{137}Cs and ^{90}Sr content of underground water. Evaluation assessment will not exceed a reasonable value, the constructed reference models can be used to solve the tasks slated taking into account geological situation.

Project Management

The Project will be carried out by the staff of the Institute of Geophysical Researches under the National Nuclear Centre of the Republic of Kazakhstan (IGR NNC RK).

Expected Results

The following outcome will result from Project execution:

1. The reference simulators making possible to account the influence of geological medium structure on distribution and migration of technogenic radionuclides resulted from underground nuclear explosions.
2. Evaluation of Balapan ground's underground water contamination with technogenic radionuclides will be carried out.

Financial Support

The following costs for Project execution are obligatory (US$):

1. Purchasing spectrometric logging instrumentation – 100 000.
2. Purchasing drilling equipment – 150 000.
3. Purchasing the equipment for hydrogeological investigations – 15 000.
4. Conducting field geological geophysical and analytical work – 80 000.
5. Performers salary – 150 000.
6. Combustible, lubricants – 20 000.
7. Communication, overhead expenses, pension fee, social imposition and additional cost tax – 185 000 approximately.

TOTAL oriented cost of the Project is about 700 000 US$.

Contribution of the Participants

Contribution of Project performer – IGR NNC RK:

- participation of high-qualified specialists – Institute research fellows – in Project carrying out and, if needed, recruiting specialists from other NNC and Academy of Sciences subdivisions;

- motor transport to convey people, material and equipment;

- deployment and elimination field bases and camps while work carrying out;

- presenting working premises both in Almaty and Kurchatov;

- presenting up-to-date computers and coping machines to treat the materials obtained.

Potential Role of American Partners

The role is as follows:

- applying experience of American colleges to shape the technique of investigations and to treat the results;

- financing the Project.

Konovalov V.E. and E.Yu. Pestov (a)
Institute of Geophysical Research NNC RK (IGR NNC RK), Kazakhstan
490021, Kurchatov, "Meridian" Site,
Telephone: 8 (322-51) 2-37-12, fax: 8 (322-51) 2-34-22, E-mail: **igr@nnc.kz**

Study Of Radionuclide Contamination Of Subsoil And Fracture Waters Of Underground River Basin Of The Degelen Mountain Range And Adjoining Territory

Project Duration – three years

Total Cost - US**$450,000**

The Problem

The underground nuclear tests had been performed in tunnels in the Degelen Mountain Range for 30 years. Many of test tunnels drilled in the rock reveal water bearing fracture structures relating to the regional underground river basin. The mountain range of about 500m high above the landscape is the wide region of precipitation drainage that nourishes underground basin. Destruction of the mountain happened as a result of nuclear tests performed, contributes for the intensive ablution of test cavity. Water contaminated with radionuclide, flows to the system of underground fracture waters and, then partially is carried out of tunnels in the current of fracture waters to the surface incidentally contaminating portal areas. Filtered in friable deposits waters contaminated with radionuclide get into the water bearing levels of subsoil waters.

During the liquidation of Semipalatinsk Test Site infrastructure (according to the Agreement between USA and RK, 1993) the borehole portals were sealed at the Degelen Range. At water bearing tunnels both open and sealed, water monitoring was performed from year 1996 – regular determinations of water production at the portals, precipitation measurements, water sampling and chemical analyses to determine anionic-cationic complex, general mineralization, radionuclide content (caesium 137, tritium) and others. Hydrogeological and chemical characteristics of underground waters were analyzed, dependence of radionuclide concentration in the water on the yield, water and its chemical composition mineralization, distribution of contamination within the territory of 200 km^2. However, in spite of all the works performed, the study, nature and scope estimation of radionuclide contamination on the territory of the Degelen Mountain Range is still the critical and urgent question, which is important for elaboration of activities on environment preservation. The necessity of work is found owing to the fact that the deep level of underground waters was not studied. Water monitoring established that the surface contamination with radionuclide is very well expressed along the bed currents. And, if the content of caesium-137 in the water was mostly reduced after tunnels sealing, the possibility of distribution of mobile tritium outside the borders of the Degelen Mountain Range appeared, where the radionuclide contamination was not studied.

Objective:

Determination of the size and water aureole configuration and currents of radionuclide distribution in subsoil and fracture waters of the river basin adjoining the Degelen Mountains.

Main Tasks:

1. Determination of the size of tritium water aureole configuration in underground waters of the Degelen Mountain Range hydrogeological basin. Study of tritium behavior in subsoil waters according to remoteness from the mountain range.
2. Determination of the size of tritium water aureole configuration in fracture waters of the Degelen Mountain Range hydrogeological basin. Study of tritium behavior in fracture waters according to remoteness from the mountain range.
3. Determination of the size and caesium 137 water aureole in underground and fracture waters of the Degelen Mountain Range hydrogeological basin

Ways to Solve the Tasks:

1. Drilling of alignments for hydrogeological screw boreholes in the line of water currents along the tritium migration ways coinciding with the direction of the constant and temporary surface water currents. Initial pitch for drilling from the borders of borehole complex is 4000m. After disappearing the radionuclide in the underground waters the detailed elaboration in back direction is performed to define the border of water current dispersion. Previously, close to the Degelen Mountains the springs and wells are studied and examined, pointed on the topographic map along the beds of the main valleys.
2. Study of tritium contamination of fracture waters is planned to be performed by way of core drilling of hydrogeological boreholes and installation of casing tubes which exclude the possibility of mixing the underground and fracture waters. Such boreholes will be drilled in case if waterproof clays are deposited in the base of loose deposits section, which separate the zone of exogenous jointing with fracture waters from underground waters. At pinching out the waterproof level fracture and underground waters are mixed. In this case the tritium water aureoles will be combined. In case of disappearing the radionuclide in fracture waters the detailed elaboration is performed in the same order as in the previous point

3. To determine the water current and caesium aureoles the hydrogeological boreholes should be drilled immediately close to caesium contaminated boreholes. It is caused by that caesium concentrates very quickly at geochemical barrier of waterlogged areas of the valleys where the large quantity of humus is kept, which is the sorbent for cation of many metals.

Management

The project will be performed under the management of IGR NNC RK.

Awaited results

1. Charts of industrial radionuclide contamination of the Degelen hydrogeological basin of fracture and underground waters at the area of 40 x 50 km.
2. Organizing of stations for water monitoring for underground contamination status in the area of the Degelen Mountains.
3. Projected models for radionuclide contamination distribution.

Costs for the program implementation

Drilling equipment	20000 $
Hydrogeological and analytical activities	90000 $

Personnel salary	250000 $
Petrol and lubricants	40000 $
Service	30000 $
Other costs	20000 $

Role of the Project Participants

IGR NNC RK drilling and hydrogeological activities, brief chemical analysis

IRSE (INP) NNC RK – analysis for radionuclide

Potential role of American Collaborators

- Determination of the survey program;
- Discussion of reports;
- Assistance in organizing and performing the surveys.

Konovalov V.E. and E.Yu. Pestov (b)
Institute of Geophysical Research NNC RK (IGR NNC RK), Kazakhstan
490021, Kurchatov, "Meridian" Site,
Telephone: 8 (322-51) 2-37-12, fax: 8 (322-51) 2-34-22, E-mail: **igr@nnc.kz**

Study Of The Danger Of Radionuclide Contamination Of The Irtysh River By Subbed And Surface Waters Of The Chagan River

Project duration – three years

Total cost - $450,000

The Problem

The Chagan river flowing into the Irtysh river runs through the Balapan site where the underground nuclear tests in boreholes were performed. The Chagan river is about 95 km long, it flows to the north from the test site border to the Irtysh river. The water runs on the surface and under ground, the underground subbed current is essentially exceeds the surface one. The most mobile isotopes – caesium 137 and tritium get into the surface and subsoil waters of the Chagan river from the range with hydrodynamic mode of subsoil waters, which run the influence of underground nuclear tests, and from the "Atomic" lake. The character and scope of radionuclide contamination of water of the Chagan river by subbed subsoil and surface waters on the way of conveying them to the Irtysh river are not well studied, though they may present the real danger for the territory where the Chagan river runs. The nature factors are not studied (structural tectonic breach, heterogeneity of filtration qualities of water bearing rocks and others) that influences the transportation of radionuclide by subsoil waters along the bed of this river. The real danger is not evaluated and the scope of radionuclide contamination of transboundary water artery – the Irtysh river that is the source of vital importance for several regions.

Objective:

Evaluate the industrial radionuclide contamination arriving with the current of surface and subsoil waters of the Chagan river for the water artery Irtysh.

Main tasks:

1. Study of the industrial radionuclide contamination of subbed and surface waters of the Chagan river in the course of its length from the STS border to the Irtysh river.

2. Determination of the volume of industrial radionuclides, arriving to the Irtysh river from the Chagan river by surface and underground way.

Ways to solve the tasks

1. *Detection of the extension of radionuclide contamination of subbed and surface waters along the Chagan river*

Drilling by auger way of hydrogeological borehole alignment down the Chagan river stream with the initial pitch of 10 km, hydro sampling (from boreholes and surface current), brief chemical analysis and determination of radionuclide content.

2. Study of the real yield of subsoil waters and flow speed at several cross sections along the length of the Chagan river.

Drilling of double cross sections of hydrogeological boreholes by auger way, test activities to determine the flow speed, evaluation of underground water yield, water sampling for the brief chemical analysis and radionuclide, calculation of the specific volume of radionuclides passing the studied cross sections.

3. *Estimation of danger scope of radionuclide contamination of the Irtysh river by subbed subsoil and surface waters of the Chagan river.*

Awaited results:

- Outlining the water current of industrial radionuclide dispersion in the Chagan river valley.
- Estimation of industrial radionuclide quantity arriving to the Irtysh river with subbed and surface waters of the Chagan river.
- Projected calculations of radionuclide inflow into the Irtysh river with subbed subsoil and surface waters of the Chagan river.
- Creating the equipped permanently functioning stations for water monitoring.
- Recommendations for organizing and realizing the water monitoring, forecasting and supervision of industrial contamination status of the Irtysh river waters, future prospect.

Management

The project will be performed under the management of IGR NNC RK.

Costs for the program implementation

Drilling equipment	15000 $
Hydrogeological and analytical activities	90000 $
Personnel salary	250000 $
Petrol and lubricants	50000 $
Service	25000 $
Other costs	20000 $.

Role of the Project Participants

IGR NNC RK – drilling and hydrogeological activities, brief chemical analysis, projected estimation, recommendations

IRSE (INP) NNC RK – radionuclide analysis

Potential role of American Collaborators

- Determination of the survey program;
- Discussion of reports;
- Assistance in organizing and performing the surveys.

Nursultan, O. and E. Tlepkaz
Director of Research Institute at the Atyrau State University, Atyrau
and
researcher, Atyrau Institute of Oil and Gas

Ecological problems developed in Western Kazakstan as a consequence of radio-nuclide pollution of Western Kazakstan and the ways to solve them.

Project Timeline: July 1, 2001 – June 30, 2004

Grant requested for the project: $500,000 (Fifty Thousand US dollars)

Atyrau oblast is located in the most ecologically threatened region in Western Kazakstan. Ural River being the only source of unregulated water flow into the Caspian Sea is also home to the natural breeding ground for sturgeon and other kinds of rare fish. This water source is constantly being polluted by toxic waste that comes from industrial and agricultural production of the cities located on upper and lower parts of the river. This waste is growing at dangerous rates: iron ions at level 8 of allowed limited concentration, oil waste from levels 4 to 17 of allowed limited concentration, just to name a few.

The presence of these components in the live organisms exceeds all acceptable limits. As a result of exposure to these toxins, there have been numerous and more frequent reports of mass diseases (sores, growth of tumors) among people, fish and seals (14,000 species of seals were affected in 2000 alone). There has been a decrease in sturgeon population and the population of other rare and endangered animals living in the Caspian region.

The area has numerous test grounds where underground nuclear as well as other modern arms tests have taken place. The total output produced by these radioactive tests are 17 ml Cure. The radio nuclides produced in underground tests find their way into the underground water wells and can be found in water consumed by local people and animals. As a consequence to the nuclear tests in the area, all radioactive elements leaked into the environment, water reservoirs, Ural River and the Caspian Sea.

It has been established that the following toxins: dimetyl-hydrogen and hydrozodietilamin found in the rocket fuel (up to 10-15 allowed limited concentration) have been spread around the region migrating from soil to plants, and consequently to humans. The health of local children is under great risk. People are reporting skin cancers, strong allergic reactions, leukemia, anemia and other diseases directly related to low immune system.

The research into ecological threats in Atyrau region has created strong interest in recent years. However, so far, all the projects were plagued with economical and logistical problems of coordinating research, funds, available technology and resources.

Project goals

- Research sources of radio-nuclide water pollution in Western Kazakstan, especially around nuclear test sites and other former military weapons sites at Azgir, Naryn, Taisoigan, etc.
- Develop a system of water controls and other mechanisms to help keep the environment in balance
- Develop recommendations for achieving continuous balance of the ecosystem, including water resources, in Western Kazakstan

Methodology

- Testing will be conducted around nuclear test sites and other former military weapons sites at Azgir, Naryn, Taisoigan, etc. to determine the overall ecological situation
- Conduct complex research into health, ecological, technological, informational and economical issues in the former nuclear and military test sites
- Develop of set of recommendations to guide sanitary and other health organizations in their work around the region
- Forecast and develop preventative programs
- Make research data available in various publications/data banks

Project Participants

Several agencies and educational institutions will participate in the project including Atyrau State University, Atyrau Institute of Oil and Gas, Atyrau Hydro-geology Department, Atyrau Health and Sanitary Departments.

Anticipated Results

Research results of this projects will be the base of the regional ecological program aimed at minimizing the effects of nuclear toxins on humans and the ways to prevent them.

Financing

Total anticipated cost of the project will be US $500,000. The following outlines expenses for the period of July 1, 2001 through June 30, 2004 for US $500,000 (fifty thousand).

#	**Expenses**	**Cost**
1.	Salaries	$150,000
2.	Research Expenses	$30,000
3.	Equipment	$150,000
4.	Travel Expenses	$100,000
5.	Expenses for involving other organizations	$70,000
	Total	$500,000 (five hundred thousand)

Project Organization

Ondagan Nursultan – project author, Ph.D. chemical sciences, professor of Physics.

- Organization and planning of the project
- Lead scientific research
- Participate in experiments and expeditions
- Prepare all intermediate and final project reports and summaries
- Prepare a set of programs and recommendations on how to preserve the environment and forecast future developments
- Publish final research results.

Richard Knapp – co-author of the project

- Organization and planning of the project
- Search for project sponsors and organize project finances
- Discuss, direct results of experiments and scientific research
- Finalizing results and issuing a set of recommendations on how to preserve the environment and forecast future developments
- Publish final results

Tlepkazy Ergaliev – project researcher, Master's in Biological Sciences, professor

- Set up and monitor scientific experiments
- Organize expeditions to former nuclear sites
- Finalizing project results
- Publish final research results.

Ptitskaya, L.D. and N.N. Belovolov
RK NNC Institute of Radiation Safety and Ecology (RK NNC IRSE), 2 Krasnoarmeiskaya St., 490021 Kurchatov, Kazakhstan, E-mail: irbe@nnc.kz, Telephone/Fax: 8 (322-51) 2-34-13

Study Of Radionuclide Transport By Ground Water At Semipalatinsk Test Site In Order To Predict Possible Effects Of Drinking Water And Geological Environment Radioactive Contamination

Project Duration – 2 years.

Total Estimated Cost – $370,000.

Project Participants
RK NNC Institute of Radiation Safety and Ecology (IRSE)
RK NNC Institute of Geophysical Research (IGR)
Institute of Global Climate and Ecology (IGCE) of Rosgidromet and RAS
Institute of Geosphere Dynamics of Russian Academy of Science (RAS IGD)

Problem Statement

Many-year nuclear testing conducted at the Semipalatinsk test site (STS) caused formation of areas where highly contaminated is not only soil but also ground water. Therefore, the study of radionuclide migration with groundwater is of particular interest in terms of providing hydrogeological and radiation-chemical safety of the environment exploitation around the Semipalatinsk test site (STS).

Project Objective

The main purpose of the investigations proposed assumes the vicissitude of research aimed at establishing regional regularities of radionuclide transit.

Main Tasks

The present project will be implemented through fulfilling the following tasks:

1. Analysis of archival information available on some of the Semipalatinsk Test Site (STS) objects considered to be most suitable for studying radionuclide migration by ground water and justification of criteria for selection of measurement locations, i.e. observation holes.
2. Development of a mathematical model of radionuclide transport by ground water.
3. Development of procedures for sampling representative water samples and analyzing them for radionuclide content.
4. Expeditions to some of the STS' objects to study radionuclide propagation by ground water.
5. Analysis of obtained data in order to forecast possible consequences of the STS groundwater contamination.

Ways to Solve Tasks Set Forth

Different scientific approaches and a set of experimental studies will be used to solve tasks set forth under the proposed project.

Task 1. Fulfillment of the task is based on systematization and generalization of archival records during the stage of office studies of library data. IRSE has a large amount of information concerning field and experimental work at STS during its operation. Good knowledge of issues related to obtaining reliable results will provide for the impartial analysis of materials available.

Task 2. Fulfillment of the task is based on development of a mathematical model of radionuclide transport by ground water. Formation of contaminated groundwater areas has a complicated spatio-temporal nature. The major routes of radionuclide transport depend upon tectonic structure of the massif and filtration and sorption properties of the water-bearing medium. A high skill level of RAS IGD and IGCE specialists will provide for a necessary work performance quality.

Task 3. Fulfillment of the task is based on elaboration of objective requirements for the composition and type of planned studies by specialists of participating institutions. The expert appraisal of data collected will make it possible to substantiate necessary details of observations. The experience gained during conduct of experiments will allow the specialists to establish recommendations on assessment of data obtained.

Task 4. Fulfillment of the task is based on a flexible adaptation approach that includes a number of different investigation methods. The searching nature of field expeditions assumes the successive refinement of forecast estimates concerning the geological environment contamination. High skills of specialists will provide for high-skill performance of the experimental work.

Task 5. Fulfillment of the task is based on elaboration of objective requirements for interpretation of results from monitoring the hydrogeological situation that determines patterns of radionuclide distribution by ground water.

Management

The project will be implemented under the leadership of the RK NNC Institute of Radiation Safety and Ecology.

Expected Results

Works proposed under the present project fall under category of applied research. Specialists in the field of nuclear testing will implement the project.

The analysis of archival information on some STS objects most suitable for studying radionuclide migration with ground water and justification of criteria for selection of reference measurement points, i.e. observation holes, will identify a new direction in the development of scientific and methodical basis for planning and implementing integrated studies of geological environment contamination.

The developed mathematical model of radionuclide transport by ground water will serve as a basis for assessing STS area contamination.

Results of work on developing a procedure for collecting and laboratory analysis of groundwater samples will be used to elaborate instructions and requirements for content, type and amount of a hydrogeological study aimed at assessment of geological environment radioactive contamination.

Results of fieldwork on study of groundwater contamination by radionuclides will serve as a basis for identifying the main factors responsible for radionuclide migration in the geological environment. The increase in informativeness and minuteness of the field work is caused by the integration of common engineering-geological, hydrogeological and geophysical methods with special hydrogeophysical methods used to search for radionuclides.

The analysis of information obtained to predict possible effects of the STS groundwater contamination is undoubtedly of a great interest for elaboration of recommendations on efficient national economy use of areas exposed to radioactive contamination and development of preventive measures for mitigation of unfavorable effects of underground nuclear testing.

Estimated Project Costs (in US$)

Equipment and materials	62960
Field and analytical work	40000
Payments to individual participants	219710
Travel expenses	29630
Overheads	18000

Potential Role of American Partners

1. Discussion of reporting documents.
2. Determination of further study areas.
3. Assistance in organization of joint workshops.
4. Provision of information useful for implementation of studied planned under project.

Subbotin, S. B.
16 Oktyabr'skaya St., Kurchatov, 490021 Republic of Kazakhstan
Tel.: (32251) 22441
Fax: (32251) 22441
E-mail: subbotin@nnc.kz ; kurlab@nnc.kz

1. **Project Title**

Organization of a Groundwater Monitoring System at Semipalatinsk Test Site

2. Project Duration

24 months

3. Total Estimated Cost

US$ 529 820

4. Background

A great number of aboveground and underground nuclear tests have been conducted by the former Soviet Union during 40 years from 1949 till 1989. These tests affected the radioecological situation in the areas adjacent. The majority of them were made at the Semipalatinsk nuclear test site (STS). Administratively, STS was located in three Oblasts of the Republic of Kazakhstan: Semipalatinsk, Pavlodar and Karaganda. The area of the test site was 18500 square kilometers. There were four test areas on the STS that were used for nuclear testing: Experimental Field, Balapan, Degelen, and Site #7. The first nuclear device was tested at the STS on August 29, 1949. Totally, according to data of RK Governmental Commission, 470 nuclear explosions have been made at STS, to include 26 above ground, 90 in the air, and 354 underground.

Areas of radioactive contamination formed after conduct of nuclear explosions undergo considerable changes with time and first of all due to migration processes of different types. Of particular importance and interest is the radionuclide migration with groundwater as this process might lead to the radioactive contamination of drinking water sources and loss of geological environment and all associated resources. Generally, migration of radioactive products from the explosion cavities can be described as follows. Two major radioactivity sources result from conduct of an underground nuclear explosion. The first one consists of radioactive aerosols and dust localized on fissure surfaces in the rock crush zone. The second one includes radioactive melt of glass and slag formed in the epicentral zone. Analysis of melt samples from explosion cavities showed that the rock melt contains from 20 to 40% of Sr-90 and from 10 to 33% of Cs-137. The remainder is distributed over the crush zone. The end cavities of boreholes and tunnels are located in different engineering-geological environment that ultimately determines conditions of radioactive products transport with groundwater. Most of the end cavities of nuclear explosions conducted in tunnels are located above the groundwater table. In this case the rock surfaces in the crush zone are washed by atmospheric precipitation rather than by groundwater. Depending upon the direction of cracks and fissures the atmospheric precipitation penetrates inside either the explosion cavity or the tunnel itself. Radioactively contaminated waters either replenish the groundwater basin or flow out to the day surface in the tunnel portal area. Tunnels with water manifestation are found in all parts of the Degelen Mountain Massif. They directly participate and cause contamination of adjacent areas. So, the total inflow of differently contaminated water from tunnels with water manifestation was about 5000 l/min, the maximum water discharge being as high as 1400 l/min. Since 1996 the NNC institutes carry out radiation monitoring of tunnels with water manifestation. Data of laboratory analysis show that in 1997 the highest specific activities of tritium, cesium and strontium were observed in Tunnel 177, Tunnel 504 and Tunnel 165 and equaled to 1725, 696 and 1400 Bq/L, respectively. The Degelen Mountain Massif is characteristic for regional fracture waters confined within the zone of exogenous weathering of rocks as well as for fissure-vein waters observed in areas with break of discontinuity. Results of hydrogeological testing of holes show that their specific yields vary from 0.001 to 0.3 l/s.

Groundwaters of the Balapan technical area are mainly confined within zones of exogenous and tectonic fractures in rocks of Paleozoic basement. They are uncovered at 2-70-m depths. The piezometric levels vary from 2 to 30 meters creating a hydraulic pressure head of up to 70 meters. Groundwaters are generally moving northeast. The end cavities of explosions conducted in boreholes are located significantly lower than the groundwater table confined within the zone of exogenous fracturing. Since below the weathering zone the groundwaters are only found in zones of tectonic disruptions, the major radionuclide migration pathways include watered zones of technogenic jointing and tectonic disruptions. So, results of laboratory analysis of groundwater samples collected from 10 non-used boreholes show that only Borehole 1419 where the specific activity of tritium was found to be 1400 Bq/l was significantly contaminated. The nearest used borehole is located over 1 km far from Borehole 1419. This is the evidence of the fact that zones of tectonic disruption where the rate of groundwater movement is higher compared to the one in the surrounding rock play the major role in distribution of water resources at Balapan Site. One of the main fractures is Chinrauskiy regional fault extending along the whole STS territory. The thickness of its fault brecciation and schistosity is as large as several hundred meters. According to data of drilling down to 600 meters, it was found that some holes have over ten watered fissure zones independent upon the depth. As a whole, the area of Balapan technical field is a complicated tectonic-abyssal joint of developed intrusions and long-lived faults. It is located at the cut point of regional faults of northwest strike and wide fractures of meridian and northeastern strike. Penetration of granitoid intrusions between faults facilitates softening of rocks originating from Hercynian age and causes formation of loose zones. Thus, the combination of factors including particular geological features of the area and effects of underground nuclear explosions on geological environment leads to a complicated geological-and-physical situation in the environment of radionuclide migration with groundwater within the Balapan technical area.

Presently, there is still little knowledge of the nature of radionuclide migration with groundwater both within the technical areas and outside them.

The present migration of radioactive products from the explosion cavities requires immediate studies aimed at elaboration of recommendations and procedures for radioecological rehabilitation of the STS groundwater. Uncontrolled mining operations conducted at the test site can result in irretrievable loss of geological environment and its resources. Geological study of the test site territory has just started but several large and small mineral deposits have been already revealed. Hydrogeological conditions in areas of prospected deposits are quite simple from the standpoint of their open-cast mining. The absence of thick water-bearing strata with large natural resources of groundwater allows classifying the deposits as middle-watered and it is very likely that their development would not be very difficult. However, it would be quite another matter when the geological environment will start to intensively change due to industrial development of mineral deposits. Construction of an open pit over 100 meters deep will result in broad depression craters which sphere of influence will include areas with underground nuclear post-explosion cavities. At the same time the gradient of groundwater piezometric surfaces will significantly rise and migration processes and groundwater movement towards the open pits will intensify correspondingly. As yet, it is impossible to predict at what stage of the deposit development the radionuclide contamination will start taking place. In this case the on-line inspection and quality control and forecast will only be possible using data of the groundwater monitoring.

Nowadays, the STS territory is actively used for different agricultural activities that often lead to changes in natural landscape, hydrogeological and engineering-geological conditions and to environment contamination. To solve the problem of eliminating the detrimental impact of the above on the environment it is required to develop and implement a complex of measures. An important place among these measures is occupied by groundwater monitoring which presents a centralized system of observation of groundwater state under impact of natural and man-caused factors. This system will also assess and regularly forecast possible quantitative and qualitative changes in underground hydrosphere state. Monitoring will be based on a system of aboveground, underground, and sometimes aerospace observations made according to a specified grid of observation locations. The effective operation of monitoring is impossible without a set of measures aimed at permanent control of ecological situation in areas of interference between objects of national economy at the STS territory and natural-technogenic systems surrounding them. Of particular importance is identification of boundaries of this interference and consequently determination of areas subject to monitoring. Outlines of areas included into the monitoring network will be adjusted as soon as new data will be obtained.

The long-term groundwater monitoring system will integrate several related packages of different types of work. The major ones of them are as follows:

Informative Package:

- establishment of a system for search, collection, storage, processing and introduction of information concerning ecological safety at the STS territory;
- creation and operation of a computer database on radioecology: planning and supervising radioecological studies, collection of research and monitoring data, on-line data processing;
- modeling and forecasting the development of ecological situation.

Experimental Part:

The topic area of research will be studying the migration of man-made radionuclides with groundwater in order to forecast transport of radioactive products from nuclear post-explosion cavities to essentially important objects of the national economy.

Methods:

- hydrogeological and geophysical studies using observation holes for precise determination of groundwater flow parameters (direction, speed, unit discharge, etc.);
- drilling additional (observation) holes in order to establish an observing system for radionuclide migration with groundwater and to prevent uncontrolled transport of man-made radionuclides to essentially important agricultural objects;
- investigation of radionuclide forms present in groundwater and sorbent properties of mountain rocks in order to develop methods for groundwater radioecological rehabilitation;

— establishment and operation of a system for observing radionuclide transport with groundwater. This system must be based on regular water sampling from observation holes according to the developed strategy for long-term monitoring of groundwater at the former STS.

Monitoring:

Objectives:

— to control potentially dangerous ecological processes involved in migration of radioactive products with groundwater at the STS;
— to obtain information necessary to provide ecological safety of agricultural activities carried out at the former STS;
— to on-line detect any unfavorable changes in development of radioecological situation as early as possible.

Basic principles for selection of monitoring locations. Since explosion cavities are directly inaccessible, hydrological holes used for regular observation of groundwater during the test site operation will comprise the monitoring network. They were drilled at different distances from boreholes and tunnels used for underground nuclear testing. These hydrological holes were mainly used for studying nuclear test effects on groundwater dynamics. Presently, these holes are out of use but their technical condition makes them well suitable for monitoring radionuclide transport by groundwater. By now, nobody knows the exact number of these holes. According to the information available, 120 hydrological holes were drilled in the Balapan test area, 10 in the Degelen Mountains, 15 at Site #7, and 10 at Site "N". Hydrogeological and hydrochemical models of the technical areas for the moment of nuclear testing termination will be developed based on results of archival data analysis. It is planned to drill five additional observation holes in order to determine the nature of radionuclide migration outside the test areas.

The permanent monitoring network may also include wells, springs, streams, rivers, and lakes located at the test site. Monitoring locations will be selected and their number will be adjusted as soon as the information about the actual size of groundwater contamination areas is obtained.

All the activities will be maximally interrelated in time and place of performance in order to reveal as much existing relationship between different events and processes as possible. Knowing this relationship will enable complete and reliable forecasting of ecological situation development at the STS using limited available data.

In conclusion it is necessary to particularly stress that establishment and operation of the groundwater monitoring network is of high scientific and practical importance. The STS with agricultural activities carried out directly in the area of the former nuclear testing is the first example of such a kind not only in Kazakhstan but also in the world practice. Therefore, the territory of the Semipalatinsk test site should be regarded as a region of a long-term integrated study.

5. **Project Objective:**

To develop a strategy for the long-term monitoring of groundwater based on the nature of groundwater radionuclid**e contamination an**d ecological-functional zoning of the former STS test areas.

6. **Task Description**

Main Milestones		
/		**Preparatory work**
	A1	Develop the investigation program
	A2	Analyze archival data on hydrogeological situation in the area of concern
I		**Conduct of work on specifying and studying the present state of hydrogeological situation and radionuclide contamination of groundwater in the former STS area.**
	B1	Perform reconnaissance surveys to determine technical condition of observation holes.
	B2	Perform pilot filtration work and collect water samples for laboratory analysis.
	B3	Carry out laboratory researches of man-made radionuclide forms present in groundwater and investigation sorbent properties of mountain rocks.
(		**Establishment of the monitoring network**
	C1	Conduct ecological-functional zoning of the STS territory.
	C2	Analyze the groundwater behavior patterns essential for potential contamination of groundwater with radioactive products of nuclear explosions.
	C3	Justify criteria for selection of monitoring-measurement network.
	C4	Perform observations planned for the first project year.
I		**Conduct of pilot monitoring observations.**
	D1	Adjust the monitoring network.
	D2	Drill 5 additional observation holes.
	D3	Perform observations planned for the second project year.
	D4	Develop a plan for plan-prophylactic maintenance of the monitoring network locations.
I		Results processing and database creation
	E1	Perform statistic processing and correlation analysis of data obtained
	E2	Develop a mathematical model of radionuclide transport with groundwater.
	E3	Develop forecasting maps for the radioactive contamination of geological environment.
		Development of the strategy for long-term groundwater monitoring at the former STS.
(		Final Phase
	G1	Analyze results obtained.
	G2	Certify monitoring locations.
	G3	Prepare the final report.

Scope of Work

In order to have a clear idea of processes associated with dynamics of radionuclide migration with groundwater, it is first of all required to develop hydrogeological models of the test site and its technical areas for the moment of underground nuclear testing termination. For this purpose archival and library data on hydrological studies conducted at the test site during its operation will be analyzed and processed in the course of the first project year. Documents subject to review are available in the archival depositories of the NNC institutes.

Two field expeditions are planned to fulfill work planned under the project.

The first field expedition will be to the STS areas of Balapan, Telkem, Degelen, "N", and #7 and will include:

- surveying the technical condition of observation holes;
- carrying-out pilot filtration works in 100 holes and collecting water samples for laboratory analysis;
- zoning the STS territory according to the ecological functionality;
- monitoring activities planned for the first project year.

The second field expedition will include:

- drilling additional 5 observation holes;
- monitoring activities planned for the second project year.

Laboratory analyses of groundwater samples for radionuclides and chemical composition will be carried out as soon as samples are collected and delivered to the laboratory.

Samples collected will be analyzed both in the field and in the INP laboratories.

Laboratory analysis:

- complete chemical analysis will be conducted for all water samples collected;
- individual samples will undergo complete and special chemical analyses;
- radionuclide content in groundwater samples will be determined using alpha, beta and gamma spectrometry methods including preliminary radiochemical separation of radionuclides of interest

Field analysis:

In order to obtain data on quantitative amount of certain water components which are unstable (like dissolved gases), some analyses will be carried out directly next to the water source following collection of samples.

Totally, over 300 different analyses of groundwater samples are planned for conduct under the project proposed.

The information obtained will be processed and analyzed as soon as it is collected in the course of project implementation. A final report on results of the two-year work under the project will be prepared and submitted in Quarter 8.

7. Project Management

Leading Institution

Name: Institute of Nuclear Physics (INP) of the RK National Nuclear Center (RK NNC)		
Address:	Street: **1 Sh.Sh. Ibragimova St.**	City: Almaty
Region:	Country: **Kazakhstan**	Zip Code: **480082**
Name of Signature Authority: Kadyrzhanov K.K.		
Telephone: **+7 (3272) 546 467**	Fax: **+7 (3272) 546517**	E-mail: **kadyrzhanov@inp1.sci.kz**
Governmental Agency: **RK Ministry of Energy and Mineral Resources**		

Project Manager

Name: Subbotin Sergey Borisovich		
Address:	Street: **16 Oktyabr'skaya St.**	City: Kurchatov
Region: *East-Kazakhstan*	Country: **Kazakhstan**	Zip Code: **490021**
Telephone: **+7 (32251) 22441**	Fax: **+7 (32251) 22441**	E-mail: **kurlab@nnc.kz**

8. Anticipated Results

The work planned in the proposed project is an applied research as findings of the project will be used in activities related to rehabilitation of groundwater in the former STS technical areas.

- The present hydrogeological situation and radionuclide contamination of groundwater will be characterized.
- The STS territory will be zoned according to its ecological functionality.
- The monitoring network will be established.
- Methodological principles for prediction of possible effects of groundwater contamination will be developed in order to elaborate recommendations on efficient nature management at the STS territory.
- The strategy for the long-term groundwater monitoring will be developed.

The former network of hydrogeological holes will be reestablished and additional holes will be drilled to monitor STS groundwater.

Based on the analysis of information obtained, a mathematical model will be developed describing radionuclide transport with groundwater and forecasting maps of geological environment radioactive contamination will be established.

9. Financial Information

Estimated Project Cost

Total Estimated Project Cost (US $)	**529 820**

Including:

Payments to Individual Participants	**210 320**
Equipment	**230 500**
Materials	**53 000**
Bank Fees	**3 500**
Other Direct Costs	**7 000**
Travel	**10 500**
Overheads	**15 000**

10. Role of Potential American Partners

- Potential co-ownership of results obtained under the project in case of their commercial usability;
- Joint papers and articles based on study results;
- Joint workshops, technical meetings, consultations;
- Advising in issues related to the intellectual property rights in case of joint inventions.

The cooperation with American partners during the project implementation, data exchange using electronic communication facilities, personal contacts during discussions of results, as well as joint publications will assist in integrating the Kazakhstani project participants into the world scientific community.

Veselov V.V., A.K. Dzhakelov, V.Y. Panichkin and B.T. Tlekin
Director of the Institute of Hydrogeology and Hydrophysics, Corresponding member of an Academy of Sciences of the Republic of Kazakhstan, Doctor of the technical sciences, professor. Tel.. 3272 918825, E-mail: v_veselov@chat.ru
Corresponding member of an Academy of Sciences of the Republic of Kazakhstan, Doctor of the geological sciences, Head of laboratory. Tel. 3272 918907
Candidate of the technical sciences, leading research officer. Tel. 3272 914609, E-mail: v_panichkin@mail.kz
Candidate of the geological sciences.

Estimation of radioactive pollution danger of underground water of the Semipalatinsk Test Site by methods of mathematical and geoinformation modeling and development of recommendations on risk lowering.

Project duration 24 months.

Common value US$ 200,000

Problem identification including history and location.

Numerous nuclear explosions in the Semipalatinsk Test Site zone led to radionuclide pollution of surface and underground water. As result of the Institute of Hydrogeology and Hydrophysics investigations at 1995-1998 showed, essential pollution of underground water is registered in region of trial areas – Myrzhyk, Degelen, Balapan where deep explosions were executed as well as on territories where surface and air explosions were executed at 1949-1963 (Kainar area).

On the *Balapan area* more than 100 fighting boreholes with depth from 70-80 to 400-450 m were drilled in the Paleozoic rocks laying under strata of clays with common thickness up to 100 m. The natural hydrogeological conditions are characterized by almost stagnant regime of underground water, hydraulic gradients are not more than thouthandth part. Underground water in the Paleozoic rocks have increased mineralization (up to 10-50 g/l) and chloridic-sodium composition. From 1992 near Balapan area (7-15 km) coal mining was started by quarry method. On 1998 beginning depth of the quarry was 35 m, yield of water reached 55-60 m^3/h, lowerings of underground water levels near quarry were up to 15-20 m. These led to moving of radioactive water from zone of location of the fighting emergency boreholes to quarry. β-activity of a quarry water increased from 0.63 Bk/l in 1995 to 24.2 Bk/l in 1998. Quarry water faulted in neighbouring falls that lead to radioactive pollution of environment.

The Degelen area, in the view of the War Department, was the most safe. More than 200 nuclear charges were placed and then were detonated in adits that were passed in granite massive with numerous tectonic dislocations. As a result of explosions, new fractures generated, processes of water-exchange increased, new springs occured at foot of mountain. The integral β-activity of underground water in springs N5 and N6 amounted 0.38 and 1.79 Bk/l in 1995, that is small. But radioactivity in pointed springs sharply increased up to 150.4 and 126.5 Bk/l after explosion of reserved charge in adit. The specific activity of strontium-90 and caesium-137 lifted some hundreds times. Since 1998 observations were stopped because absence of financing.

Large radioactivity of underground water was also determined on the Myrdzyk-Saryozen area. Radioactive water is coincided with fractured intrusive and sedimentory rocks of Paleozoic.

Radioactive pollution of surface water was determined in the rivers – Shagan, Karasu. Radioactive pollution in the Irtysh river near Semipalatinsk is small – 0.06-0.07 Bk/l. Near Kurchatov c. it is increased up to 0.58Bk/l. Integral β-activity of water reach 1.6-3.85 Bk/l in lakes Koyansu and Atomnoye, it is 3 times more than permissible level.

Underground and surface water of region are used by domestic population for drinking and irrigating of pastures. There is real danger of radionuclides hit in water intake buildings.

Objectives: To examine aureole of radionuclide pollution of underground and surface water in the region of the Semipalatinsk Test Site, to forecast it's following dissemination, to estimate danger for environment and to develop recommendations on risk lowering.

Description of problems

Collection, generalization and analysis of archive hydrogeological materials

T1. Conducting of field investigations with sampling of springs, open reservoirs and active water intake holes

T2. Creation of geoinformation model and analysis of current aureole of the radionuclide pollution of underground water

T3. Creation of mathematical model of hydrogeological conditions and forecasting of dissemination of radionuclide pollution of underground water

T4. Preparation of recommendations on risk lowering

Project management

First year

In first year middle, meeting with foreign participants of the project is planned for definition of main investigation directions, coordination of joint works plan, as well as discussion of preliminary results. Dispatching of foreign participants in Almaty with duration on 7 days is planned for it. Dispatching of the Institute of Hydrogeology and Hydrophysics research assistants for execution of field works in the Semipalatinsk Test Site is planned with duration on 4 months. Also rent of motor vehicle (duration 4 months). 30 samples of underground and surface water will be taken for definition of content of radionuclides, integral α- and β-radioactivity. Acquisition of software and hardware is planned for creation of geoinformation system. Efficient communication with foreign project participants is planned to execute through E-mail and FAX. Also expenses on materials and components of computer equipment are envisaged.

Second year

Acquisition of GMS 3.1 modeling system is envisaged for creation of computer model of radionuclide pollution of underground water. In second year middle, meeting with foreign project participants is planned for presentation of preliminary modeling results, consultations and coordination of plan of field works conducting. Dispatching of foreign partners to Almaty with duration on 7 days is planned for it. Dispatching of the Institute of Hydrogeology and Hydrophysics research assistants to the works region with duration on 4 months and rent of motor vehicle (duration 4 months) is envisaged for field works execution in the Semipalatinsk ground. 20 samples of underground and surface water will be taken for definition of radionuclides content and integral α- and β-radioactivity. There are envisaged expenses for communications, materials and components for computers.

Calendar plan of works execution

Problems	1-6 Months	7-12 Months	13-18 Months	19-21 Months
T1	XXXXXX			
T2		XXXX		XXXX
T3	XXX	X XX		X
T4			XXXXXX	XX
T5				XX

Expected results

As a result of project realization, it will be investigated current aureole of radionuclide pollution of underground and surface water in the Semipalatinsk Test Site region, forecasted it’s future dissemination through mathematical model, estimated risk and prapared recomendations on it’s lowering.

Financing (estimate of expeditures)

Expenses, $ USA	First year	Second year	Total for 2 years
Wages	20000	20000	40000
Equipment and expensed materials	9500	9000	18500
Dispatching	14000	14000	28000
Services of indirect organizations	3000	3500	6500
Sum:	46500	46500	93000
Overhead expenses (15% from sum)	7000	7000	14000
Total:	100000	100000	200000

Contribution of participants including material and other expenses

The Institute of Hydrogeology and Hydrophysics has main part of materials on radionuclide pollution of underground and surface water of the Semipalatinsk Test Site. Institute will put necessary rooms, 5 computers (from PII-200 to PIII-700) jointed in local network for execution works on the project.

Potential role of American partners

It is proposed that American partners will give necessary methodical help, put modern software and consultations on it’s effective use.

Vetrinskaya N.I., I.Ya. Kleinbok and E.T. Nikitina
Institute of Geophysical Researches under the National Nuclear Centre of the Republic of Kazakhstan, Geophysical Observatory "Kaskelen".
Address: 191, Abaya Ave., Almaty, 480046.
Tel.: (8-3272) 46-99-02, 46-99-56
Fax: (8-3272) 46-99-56
Email: igr@kaskelen.almaty.kz

The Institute of Men's and Animals' Physiology, Ministry of Science and Education of the Republic of Kazakhstan.
Address: 32, Akademgorodok, Almaty, 480032
Tel.: (8-3272) 62-38-40
Fax: (8-3272) 49-18-33

The Institute of Microbiology and Virology, Ministry of Science and Education of the Republic of Kazakhstan.
Address: 103, Bogenbai-batyr Str., Almaty, 480100
Tel.: (8-3272) 91-97-36
Fax: (8-3272) 91-75-03

Investigation of Natural Water Quality (Ecological Aspect) of the Former Semipalatinsk Nuclear Test Site (SNTS) Using Biological Objects of Different Classification Groups

Project Duration: 3 years (36 month)

Estimated Total Cost of the Project: 350 000 (US$)

Project Background

The task of economic development of the former SNTS territory is set in the Republic of Kazakhstan. In this connection, ecological monitoring of the environment within this territory becomes the most significant task.

There was a great number of underground nuclear explosions taken place in the Republic of Kazakhstan for several decades and main part of them are concentrated within the SNTS. High explosion density within the confined territory, specific geological conditions and developed hydrogeological network dictate the necessity to begin the work to find out the degree of nuclear explosion effect on natural water state.

There is a range of water sources that have exposed to and are still exposing to ionizing radiation in the SNTS area and adjacent territories. Taking into account complication of chemical substance and biological object interaction in water structure, complex investigation of natural water biological quality is of undoubted significance (Luk'yanov A.T., et al., Bulletin of Kazakh SSR, n.10, 1990; Antonchenko V.D., et.al., Foundations of Water Physics, Kiev, 1991).

Menacing scope of technogenic contamination in the vast territory of the former SNTS and adjacent territories being taken into account, one should obtain simple and effective means to carry out rapid evaluation of biological quality of water, under field conditions especially, where different toxicants can be found, including migrating radionuclides.

Of late years, attempts are undertaken in different world's countries to bring about control of environment contamination with the help of integral index of general contamination level. The index of water toxicity can be used as such an index.

Toxicity as integral and obligatory normative index of water quality is controlled in Denmark, France, Germany, Ireland, the Netherlands, he Great Britain, Norway, Belgium, Sweden, Switzerland, Canada, the USA, Australia.

Investigations showed the complex analysis including, together with the express methods of chemical control, biotesting analytical systems on the base of microorganisms and other the simplest micro-organisms to be the most promising to determine toxicity. Moreover, biotesting methods are used more and more frequently for ecological monitoring as obligatory ones. (Ganapathy S. // BARC.[rept].- 1994 / № P001 .- p.32.; Reicken Uwe // Forsch. Strassenbau und Strassenverkenrstech. - 1993, № 636. p. 49-61; Burgeot T. et al.// Oceanis.- 1994. - 20, №3. - p.79-88; Dobbs Michael G. et al. // Environ. Toxicol. and Chem. - 1994.- 13 №6. - p.963-971; Israel Yu.A. Complex Global Monitoring of Environment Contamination, L. 1980; Burdin K.S. Complex Global Monitoring of Environment Contamination, L. 1982; Emel'yanenko V.V., et.al. Generalized Indexes of Water Quality-83. Practical Issues of Biotesting and Bioindication. Chernogolovka, 1983; Igimberdiev V.M. Collected Scientific Papers, S.-Petersburg 1991, p.71-84; Naboko M.V. Hygiene and Sanitary, 1993, N6, p.75-76; Dmitriva A.G., et.al. Ecological Systems and Apparatus, N 11999, p.41-44; "The Rules of Ground Water Protection. Typical Issues" (Moscow, 1991).

The necessity of complex analysis namely, including biotesting methods as obligatory element, is founded on the fact that the existing methodology of normalization and control does not correspond to up-to-date requirements of ecological control due to the following reasons:

- only a small part of contamination indexes actually existing in a medium is involved;
- complex effect of all contaminants on the processes of self-decontamination in water bodies and soil is not taken into account;
- only an insignificant part of all the substances revealed by analytical methods is controlled;
- effects of synergism and antagonism of the chemical compounds present in natural water and soil do not reveal (Gelashvili D.B., et. al., Ecology and Industry in Russia, Oct., 1998, p.30-36; Usov G.P., Ecology and Industry in Russia, Aug. 1999, p.32-33).

To evaluate biological quality of SNTS natural water, biotesting with the help of organisms of different classification groups as test-objects (micro-organisms, algae, higher water plants, mammals) is proposed to be brought about. Biophysical test-functions are suggested to be used as test functions along with the generally accepted ones.

The newest developments in the field of biological testing manifested the advantage of using of the biotesting analytical systems founded on biophysical methods (luminescence, fluorescence, electric conductivity, etc.). These methods are one or two order of magnitude more sensible and rapid than other test-functions, because they react to medium effect on bioenergetic structures first of all revealing themselves as biophysical violations, namely, being recorded immediately after the influence (Nikolaevskaya T.V., "Methodological Economical Regulation", Kharkov, 1990; Knyazeva N.I., et. al. Materials of International Symposium "Biological Indicators and Biological Monitoring, Zagorsk, 1991).

In this connection, complex investigations are stipulated by the Project including quality analysis of the water exposed to ionizing radiation from the standpoint of ecology with the help of biological testing procedures.

Goal of the Project

Solving the problem of evaluating the biological quality of SNTS natural water and elaborating the complex method for rapid and cost-effective analysis with a view of ecological monitoring.

Complex investigation of biological quality of the SNTS' water will conduce to creation of the scientific base to forecast the effects stipulated by interaction of the water exposed to radiactive rdiation with different biological objects, to monitoring of radinuclide contamination in the sites of nuclear explosions carrying out, to development the methods of treating and rehabilitation of the people exposed to radioactive radiation, etc.

Description of the Tasks

Task 1.

Assessment of hydrogeological state of the sites of assay sampling; assay sampling.

Material collection and database compiling on hydrogeology of the areas where nuclear explosions took place.

Radiometric measurements of total alpha-, beta- and gamma activity in the sites of assay sampling.

Task 2.

Determination of ecological quality of water using prompt microbiology test systems. Investigation of the influence of the studied SNTS water assays on luminescence intensity of luminous bacteria.

Investigation of membrane penetrability of different micro-organisms' cells, while incubating in the samples of SNTS toxic water.

Revealing of cancerogenic effects of the toxic water sampled in the SNTS with the help of microbiological model of tumour growth.

Task 3.

Evaluation of ecological quality of radiocontaminated water assays sampled in the SNTS according to biophysical test-functions of algae and higher plants.

Determining degree of toxicity of the SNTS water samples according to the results of investigations of Elodea's cells membrane penetrability.

Investigation of chlorophyll colour intensity as an indicator of photosynthesis intensity of Chlorella and Elodea.

Morphological changes and growth intensity of higher water plants (Elodea) while long-term incubating in the samples of SNTS toxic water.

Task 4.

Influence of the SNTS water samples on thermal and mechanical perceptibility of skin and the state of mammal's autonomic nervous system.

Investigation of the thresholds of temperature and mechanical perception by skin's receptors of mammals under the influence of SNTS water samples.

Evaluation of the state of peripheral nervous system according to alteration of its sympathetic potential,

Assessment of vascular reactions of extremities under the influence of SNTS water samples.

Task 5.

Compiling the database containing medical and biological information.

Task 6.

Interpretation of the received complex results.

Project Management

The Project will be carried out by the staff of the Institute of Geophysical Researches under the National Nuclear Centre of the Republic of Kazakhstan (IGR NNC RK).

Expected Results

The proposed Project is classified as an applied investigation. Investigations performed will result as follows:

- complex investigations on estimation of toxicity of the nature water contaminated with radionuclides by biological testing methods using biological organisms of different classification groups (micro-organisms, algae, higher water plants) as test objects will be carried out; besides, unique water samples from the sources not far from the chambers where nuclear explosions took place will be used;
- estimation of irradiated water influence upon intensity of biological luminescence of luminous bacteria will be conducted;
- estimation of irradiated water influence upon membrane penetrability of micro-organisms' cell suspension will be carried out;
- estimation of irradiated water toxicity according to functional state and rising of microbiological model of tumour growth will be made;
- estimation of irradiated water influence upon membrane penetrability of vegetable cells will be carried out;
- estimation of irradiated water influence upon intensity of photosynthesis processes of algae and higher water plants will be carried out;
- estimation of irradiated water influence on temperature perception of mammals, tone of its autonomic nervous system and on vascular reactions of its upper extremities will be made, that will enable approaching elucidation of the mechanisms of irradiated water effect upon the elements of nervous system perceiving external exposures and forming, to a certain extent, response of mammal's organism to environmental irritants.

Inexpensive analytical procedure of express evaluation of water fitness for men consumption, which can be used by nature protection organization while monitoring nature waters, will be worked out as a result of the Project execution.

In addition, possibility of recycling of some SNTS areas to economic activity will be studied as a result of the work as well. These results are of vital importance for the Republic of Kazakhstan since it enables estimating hazard degree for the population dwelling not far from the sites wherein water resources have exposed to ionizing radiation to a different extent.

The results obtained will be useful for economy and civil requirements of Kazakhstan, and will contribute to a certain extent to world scientific experience of investigations of underground nuclear explosion consequences.

Financial Support

The following costs for Project execution are obligatory (US$):

1. Performers salary – 189 150.
2. Equipment – 64 651.
3. Materials – 9955.
4. Other direct expenses – 2864.

5. Business trip expenses – 56543.
6. Overhead expenses – 26837.

Contribution of the Participants

Laboratory premises, equipment available, motor-transport, intellectual potential.

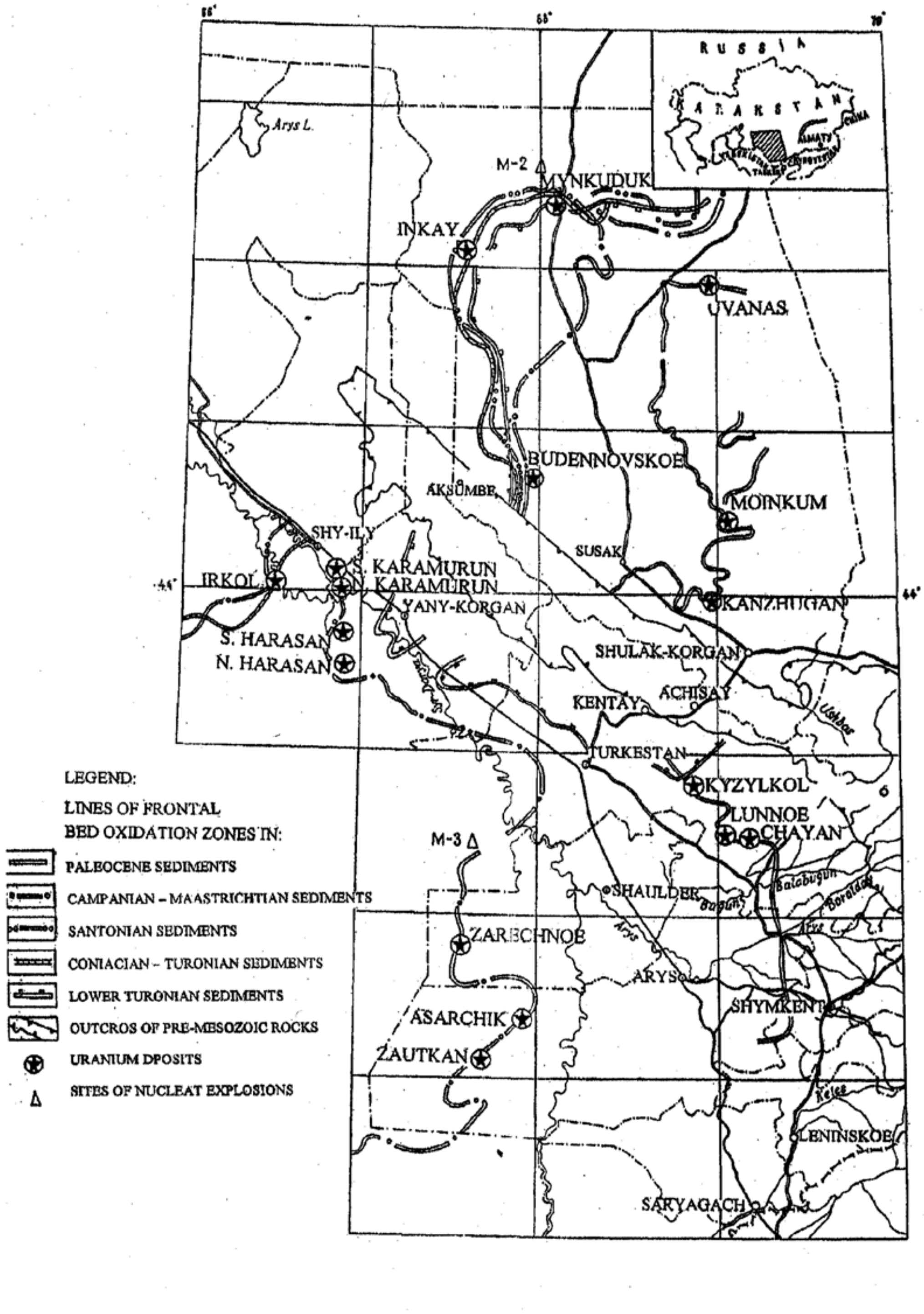
Potential Role of American Partners

Financial support of the Project, counselling.

Presentations (English)

Uranium In Situ Leaching: Kaukov

Figure 1. SURVEY MAP OF URANIUM ISL-PROVINCES IN KAZAKHSTAN



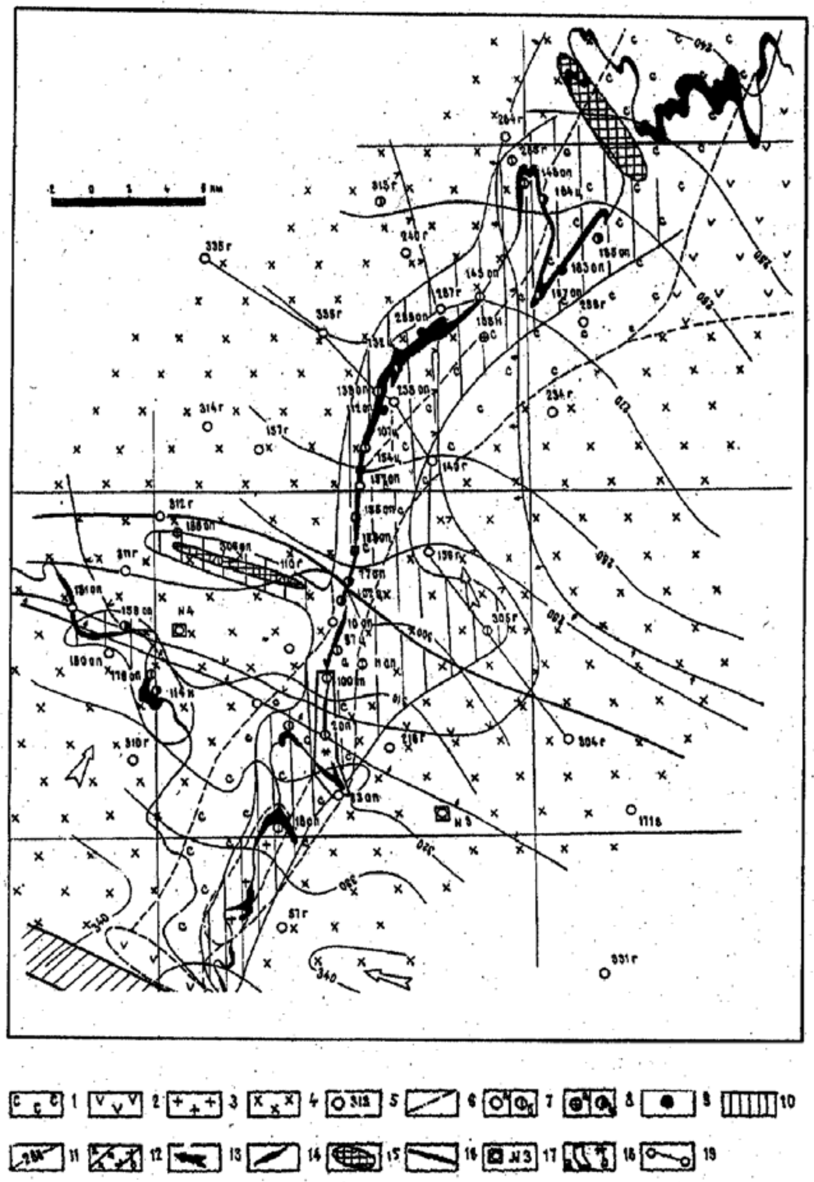


Fig.2 Radiohydrogeochemical scheme of uyuck horizon P_2uk

1- 4 – chemical composition of groundwater: 1 – sulfate-carbonate sodium; 2 – chloride – carbonate sodium; 3 – chloride – sulfate sodium; 4 – hydrocarbonate – chloride sodium; 5 – hydrogeological well and its number; 6 – a boundary of a groundwater spread of different chemical composition; 7 - 9 – content of radium-226 in groundwater, multiple to the control level from NRB-96 (Standards of Radiation Safety): 7a – less 1, 7b – 1-3, 8a – 3-5, 8b – 5-10, 9 more 10; 10 – a contour of projection of groundwater parts with content of Radium-226 more than the control level; 11 – an absolute potentiometric level, m; 12 – a projection of limits of artesian basin: a – in 1983 year, b – in 1989 year; 13 – a main direction of groundwater flow; 14 – uranium ore bodies (zalezhes); 15 – a local uplift in Paleozoic basement; 16 – a fault; 17 – a water supply facility and its number; 18 – an IS-leaching polygon: a – active production, b – experimental in past; 19 – ecological-hydrochemical cross-section.

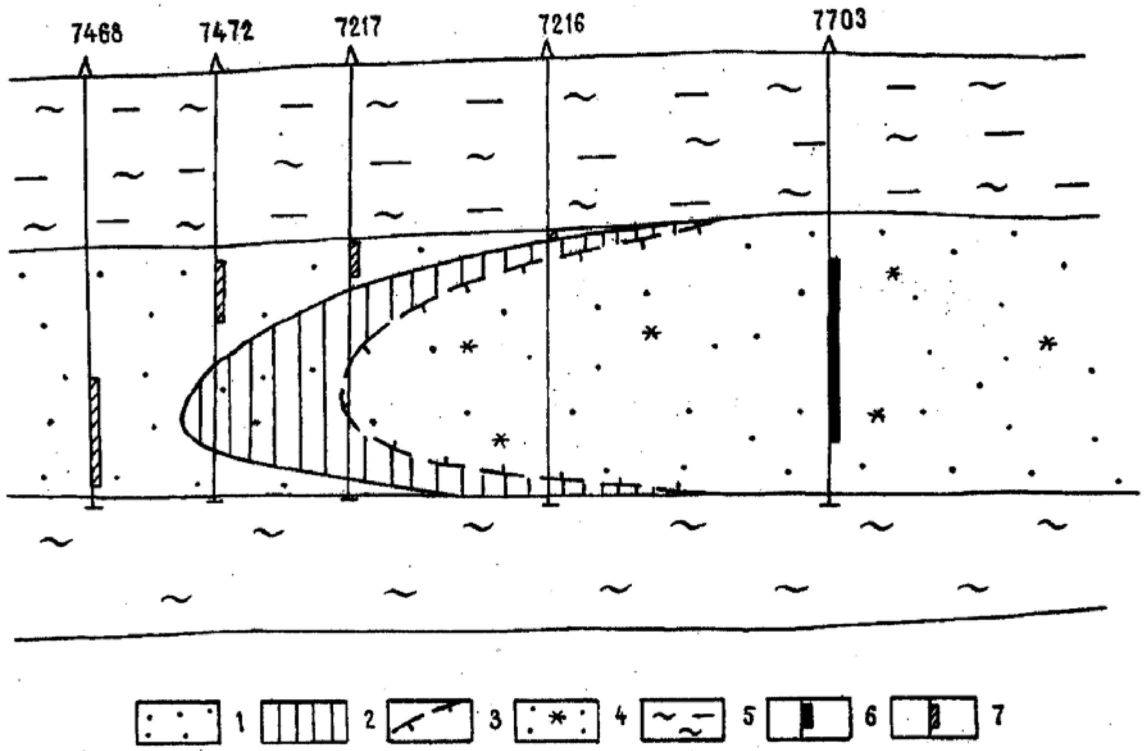


Figure 3. Schemes of sampling on uranium deposit North Karamurun.

1 – zone of primary gray colored sand,
2 – zone of uranium ore bodies,
3 - boundary of frontal bed oxidation,
4 – zone bed oxidation,
5 – clayey confined layer,
6 – location of making sample 7 – yellow oxidized sand,
7 – locations of making sample 6 – primary gray colored sand.

Figure 4. A Radiohydrochemical log through Moinkum Uranium deposit

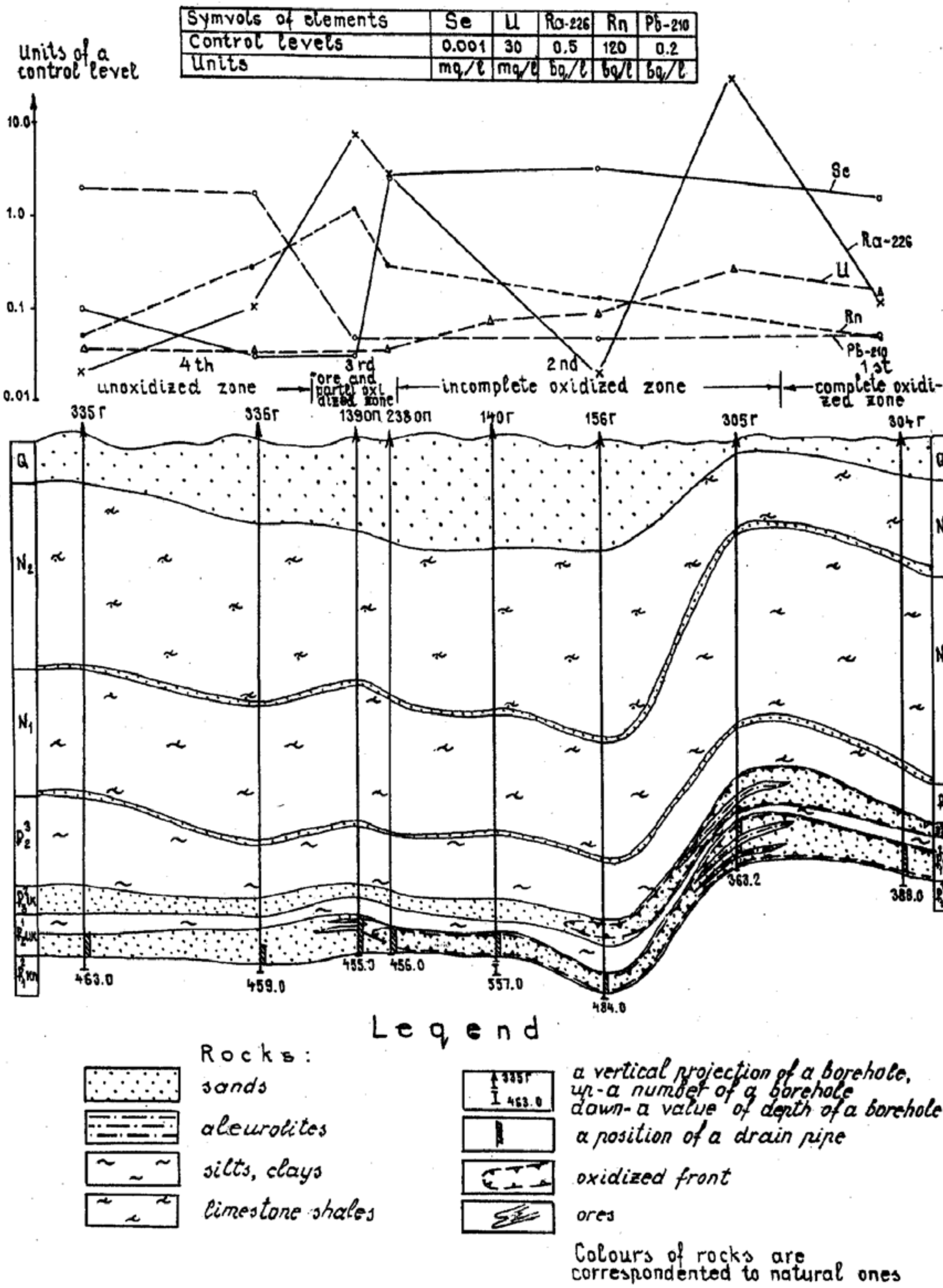


Figure 5. A preparation of washed water, sample 84. The character of distribution of soluble (90%) and dispersed (10%) (spots in the center) phases. The main mineral of the solution is needle-like gypsum and its spherical separations in the margin of the preparation. Magnifying x25, parallel nicol prisms (P-).

Figure 6. A preparation of washed water, sample 84. A needle-like ~~of~~ gypsum, incrustate close-grained aggregation of melanterite. On the left is coaxial globule of gibbsite. Polydispersed structure and polycomponent composite of the margin of the preparation, small crystals of melanterite and needles of gypsum.

Table 1.

Chemical composition of different water types in Kanzhugan uranium deposit.

NN of wells	TDS, mg/l	ions, mg/l				cations, mg/l				pH
		HCO_3^-	Cl^-	SO_4^{--}	NO_{2-3}^-	Ca^{++}	Mg^{++}	Na^+	K^+	
1007y	478	183	44	114	2	48	17	68	2	7.4
70on	802	220	120	225	n. a.	88	22	126		7.7
85r	845	208	184	199	n. a.	80	32	142		7.6
30on*	895	341	127	158	n. a.	48	15	205		7.2

Underlined magnitudes prefer to others by considering molecular weight of a chemical compound.
*It is noticed a smell of hydrogen sulfide.

Table 2

Medial contents of basic chemical compounds influencing on distribution of uranium on the geochemical zones

Type of rock	C o n t e n t s, %					
	Fe^{+2}	Fe^{+3}	S^{-2}	C_{org}	CO_2	P_2O_5
Unoxidized silts and clays	0.39	0.52	0.78	0.09	0.14	0.018
Unoxidized oreless sands	0.12	0.16	0.16	0.06	0.06	0.015
Unoxidized ore's sands	0.16	0.18	0.32	0.32	0.08	0.015
Oxidized sands	0.05	0.09	0.04	0.02	0.09	0.014

Table 3

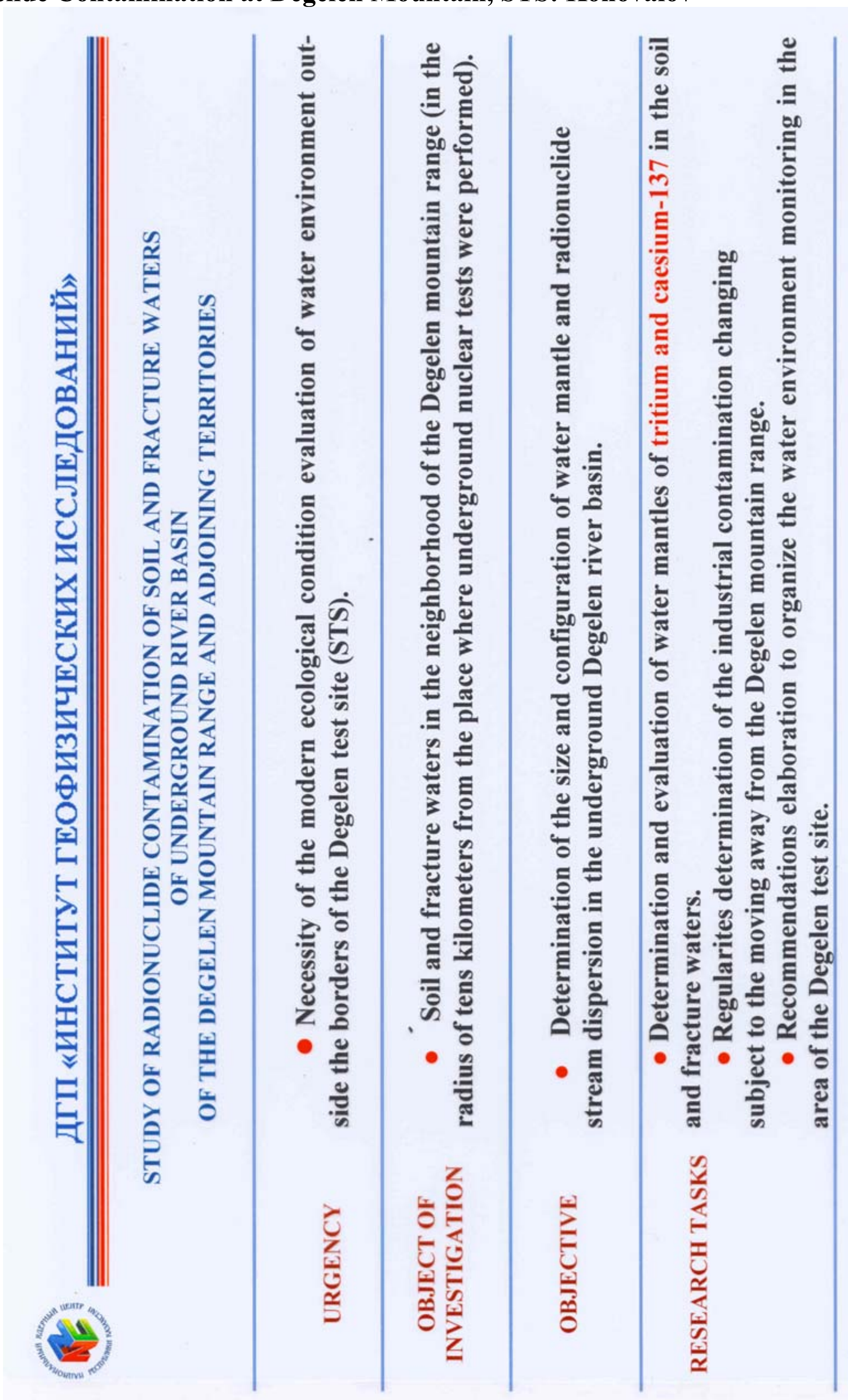
Medial mineral content

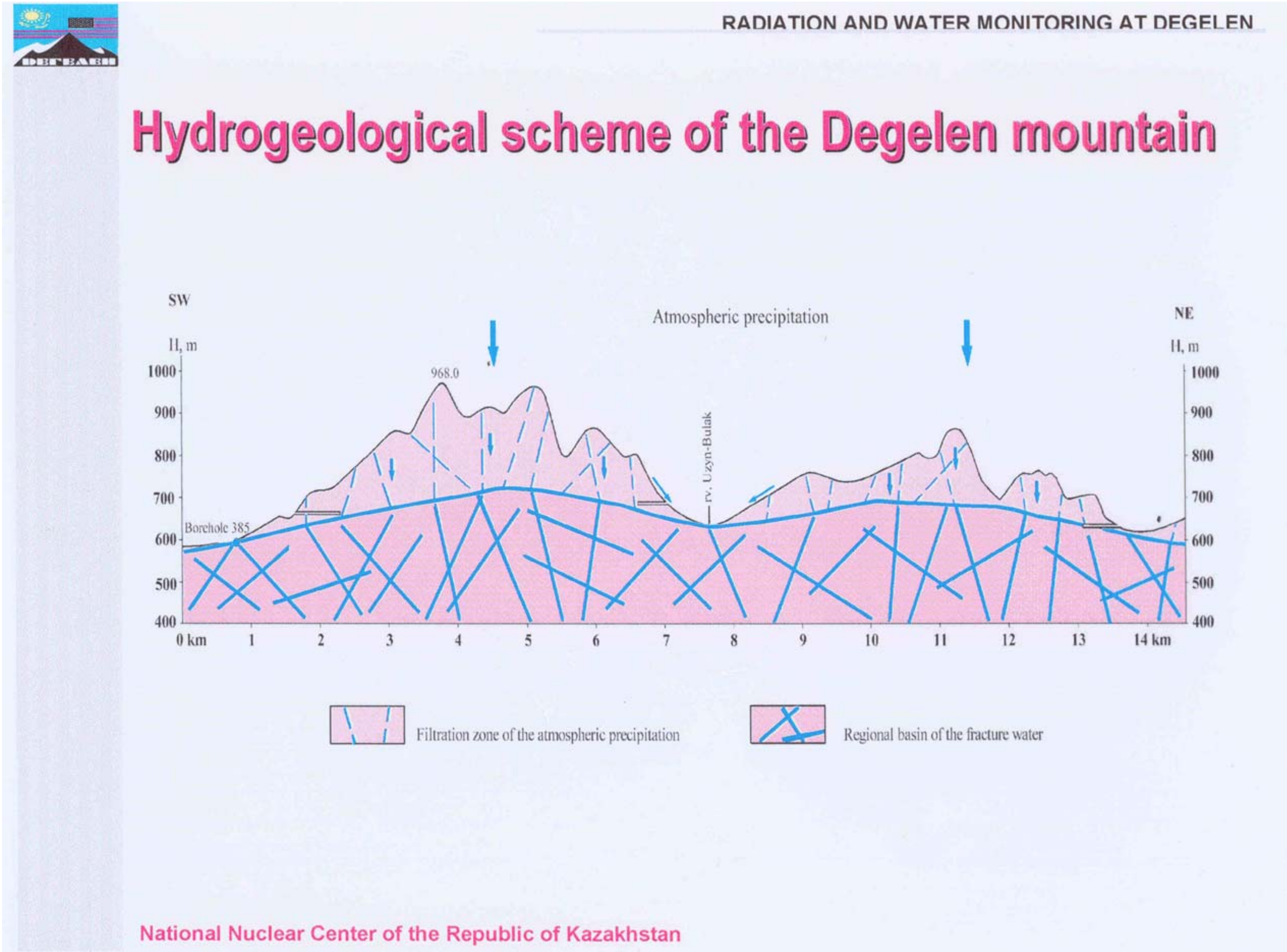
Type of rock	Contents, %							
	Unsoluble				Weak soluble			
	Quartz	Accessory	Siliceous fragmentary	Total	Common feld spar	Mont-morillonit	Kaolin	Hydromica
Unoxidized silts and sands	44.3	0.3	1.8	46.4	6.0	16.4	16.4	8.0
Unoxidizid oreless sands	78.1	0.4	1.7	80.2	9.8	1.8	2.7	0.8
Unoxidized ore's sands	78.1	0.4	1.7	80.2	7.2	2.7	3.1	1.2
Oxidized sands	77.3	0.4	2.0	79.7	9.1	2.7	2.6	1.2

Type of rock	Contents, %								
	Weak soluble				Soluble				
	Chlorite	Muscovite	Bioclastic rock	Total	Carbonate	Sulfide	Limonite	Phosphate	Total
Unoxidized silts and sands	1.2	3.1	1.0	52.1	0.4	0.5	0.3	0.2	1.4
Unoxdized oreless sands	-	3.6	0.4	19.1	0.1	0.4	<0.1	-	0.5
Unoxidized ore's sands	<0.1	2.8	1.5	18.5	0.1	1.1	<0.1	<0.1	1.2
Oxidized sands	-	3.7	0.3	19.6	0.1	0.1	0.4	<0.1	0.6

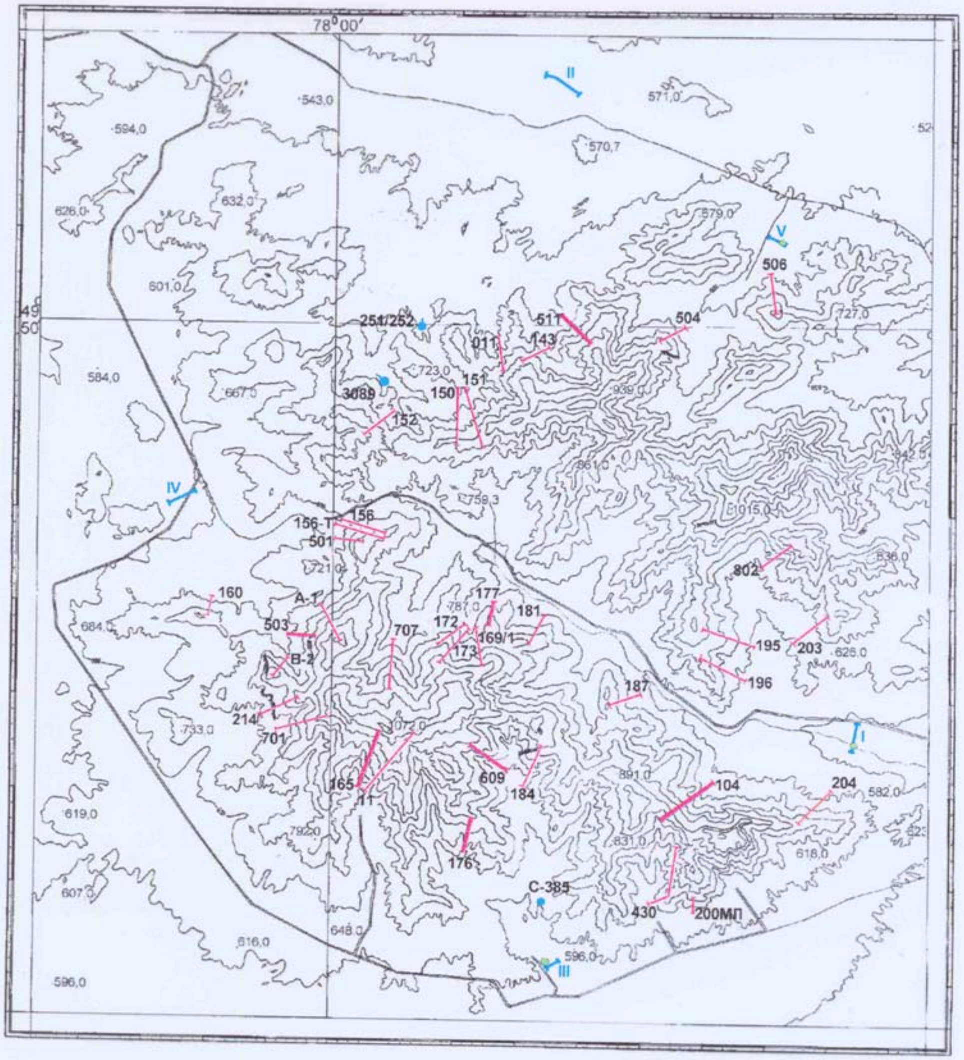
Table 4. Mineral composition of authigenous mineralization in sand of Karamurun ore horizon

Mineral composition					
Basic		Secondary		Rare	
Analcime	$NaAlSi_2O_6*H_2O$	Albite	$NaAlSi_3O_8$	Anglesite	$PbSO_4$
Ankerite	$Ca(Fe,Mn,Mg)(CO_3)_2$	Allophane	$Al_2O_3*SiO_2*nH_2O$	Crandallite	$CaAl_3(PO_4)_2(OH)_5*H_2O$
Calcite	$CaCO_3$	Alumen	$KAl(SO_4)_2*12H_2O$	Cu sulphate	
Chabasite	$CaAl_2Si_4O_{12}*6H_2O$	Bitominous substance		Dolomite	$CaMg(CO_3)_2$
Common opal	SiO_2	Carbonate-apatite	$Ca_5(PO_4CO_3)_3(OH,F)$	Jarosite	$KFe_3(SO4)_2(OH)_6$
Desmine (Stilbite)	$NaCa_2Al_5Si_{13}O_{36}*14H_2O$	Coquimbite	$Fe_2(SO_4)_3*9H_2O$	Mellite	$Al_2[C_6(CO\ O)_6]*18H_2O$
Gibbsite	$Al(OH)_3$	Dickite	$Al_2Si_2O_5(OH)_4$	Mg-hydroscopic mineral	
Glauconite	$(K,Na)(Al,Fe^{3+},Mg)_2$ $(Al,Si)_4O_{10}(OH)_2$	Ferriferous oxides and hydroxides		Siderite	$FeCO_3$
Heulandite	$(Na,Ca)_{4\text{-}6}Al_6(Al,Si)_4$ $Si_{26}O_{72}*24H_2O$	Gypsum	$CaSO_4*2H_2O$	Sodalite (?)	$Na_4Al_3Si_3O_{12}Cl$
Montmorillonite-1	$R_{0,33}Al_2Si_4O_{10}(OH)_2*nH_2O$	Marcasite	FeS_2		
Montmorillonite-II	where R is one or some of Na^+,K^+,Mg^{2+} and Ca^{2+}	Mirabilite	$Na_2SO_4*10H_2O$		
Noble opal	SiO_2	Orthoclase	$KAlSi_3O_8$		
Opal-CT-I	SiO_2	Phosphates			
Opal-CT-II		Pyrite	FeS_2		
Palygorskite	$(Mg,Al)_2Si_4O_{10}(OH)*4H_2O$	Se-mineral			
Quartz	SiO_2	Uranium oxide			
Sepiolite	$Mg_4(Si_2O_5)_3(OH)_2*6H_2O$				
Silicic alumogel					


ДГП «ИНСТИТУТ ГЕОФИЗИЧЕСКИХ ИССЛЕДОВАНИЙ»
STUDY OF RADIONUCLIDE CONTAMINATION OF SOIL AND FRACTURE WATERS
OF UNDERGROUND RIVER BASIN
OF THE DEGELEN MOUNTAIN RANGE AND ADJOINING TERRITORIES
URGENCY
Necessity of the modern ecological condition evaluation of water environment outside the borders of the Degelen test site (STS).
OBJECT OF INVESTIGATION
Soil and fracture waters in the neighborhood of the Degelen mountain range (in the radius of tens kilometers from the place where underground nuclear tests were performed).
OBJECTIVE
Determination of the size and configuration of water mantle and radionuclide stream dispersion in the underground Degelen river basin.
RESEARCH TASKS
Determination and evaluation of water mantles of tritium and caesium-137 in the soil and fracture waters.
Regularites determination of the industrial contamination changing subject to the moving away from the Degelen mountain range.
Recommendations elaboration to organize the water environment monitoring in the area of the Degelen test site.


RADIATION AND WATER MONITORING AT DEGELEN
Hydrogeological scheme of the Degelen mountain
SW
NE
Atmospheric precipitation
H, m
1000
900
800
700
600
500
400
968.0
Borehole 385
rv. Uzyn-Bulak
0 km
1
2
3
4
5
6
7
8
9
10
11
12
13
14 km
Filtration zone of the atmospheric precipitation
Regional basin of the fracture water
National Nuclear Center of the Republic of Kazakhstan

Map of Hydrogeological Objects



Tunnel with inflow in 1996, 1997, 1998

Tunnel with constant inflow

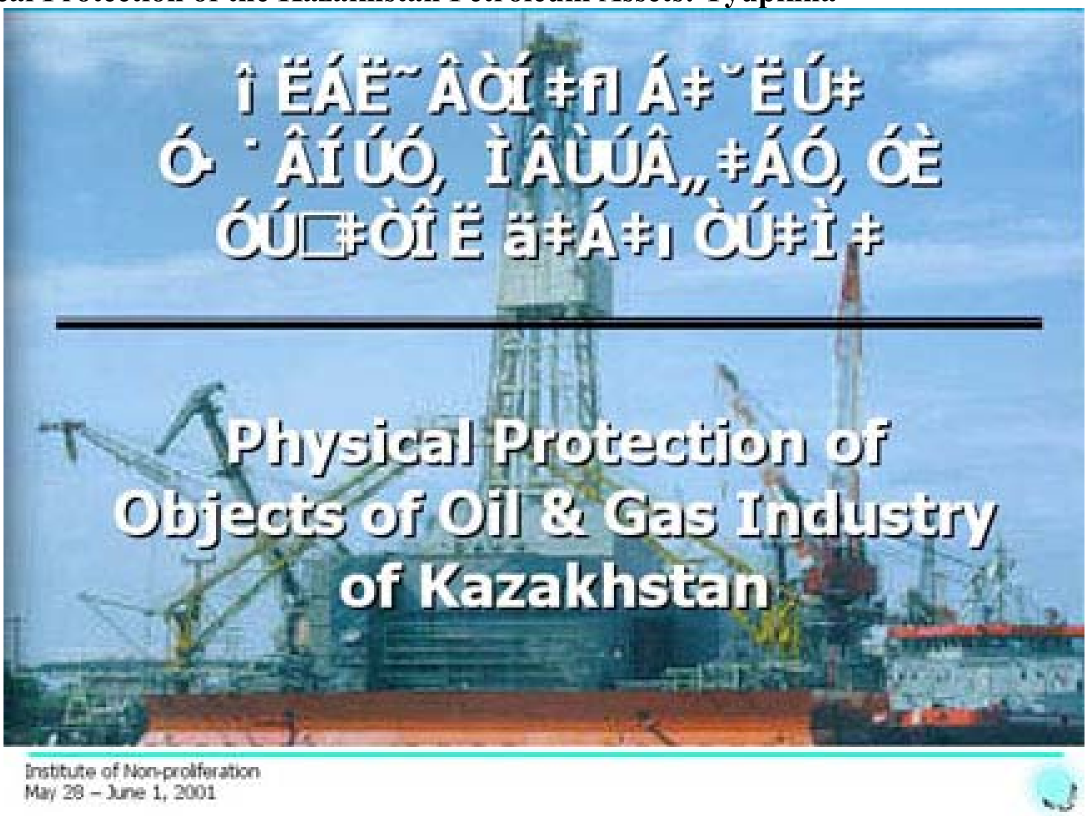
Hydrogeological Profile

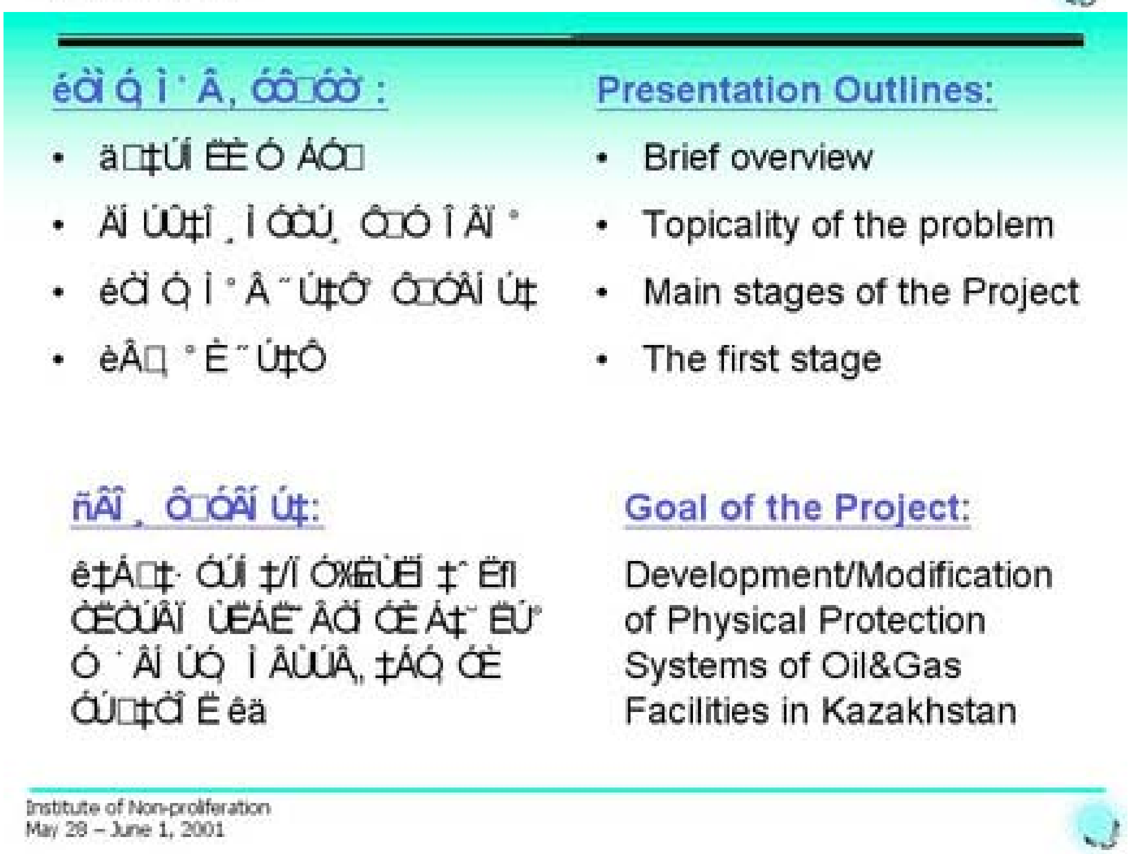
Spring

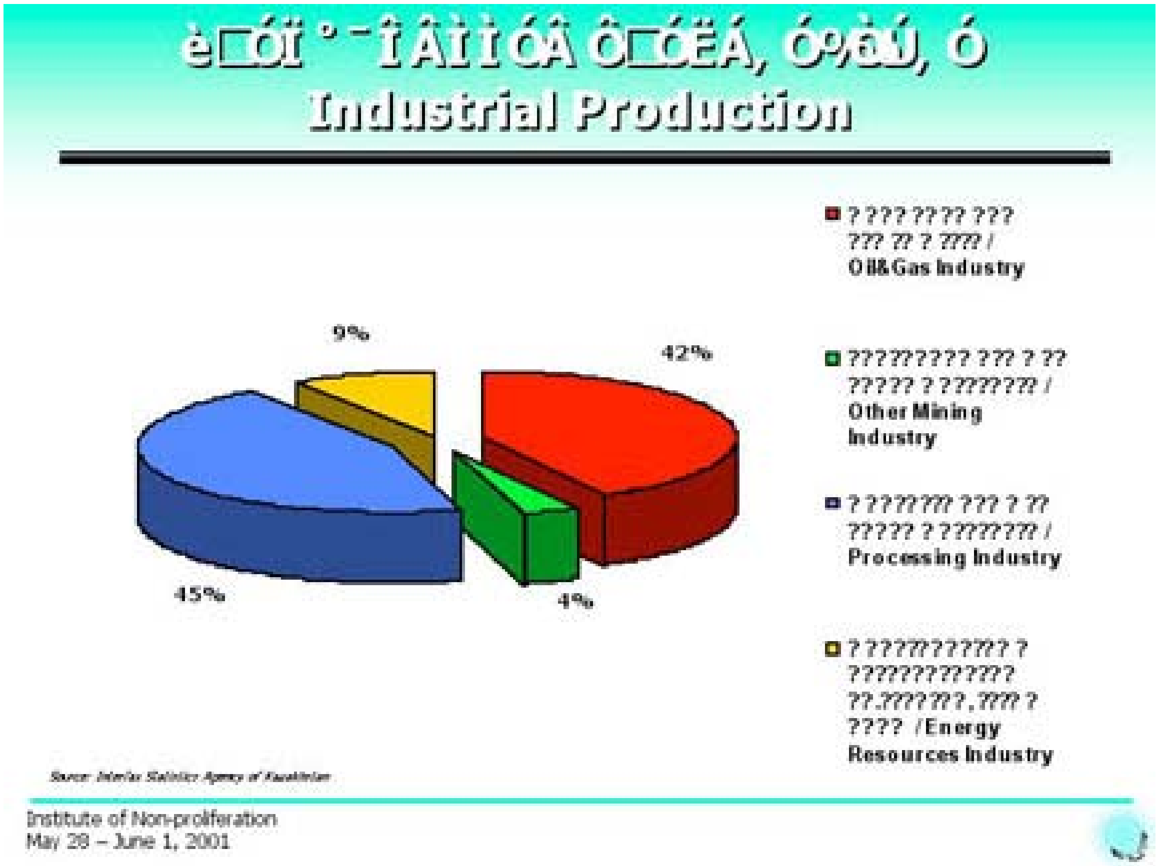
Flowing well

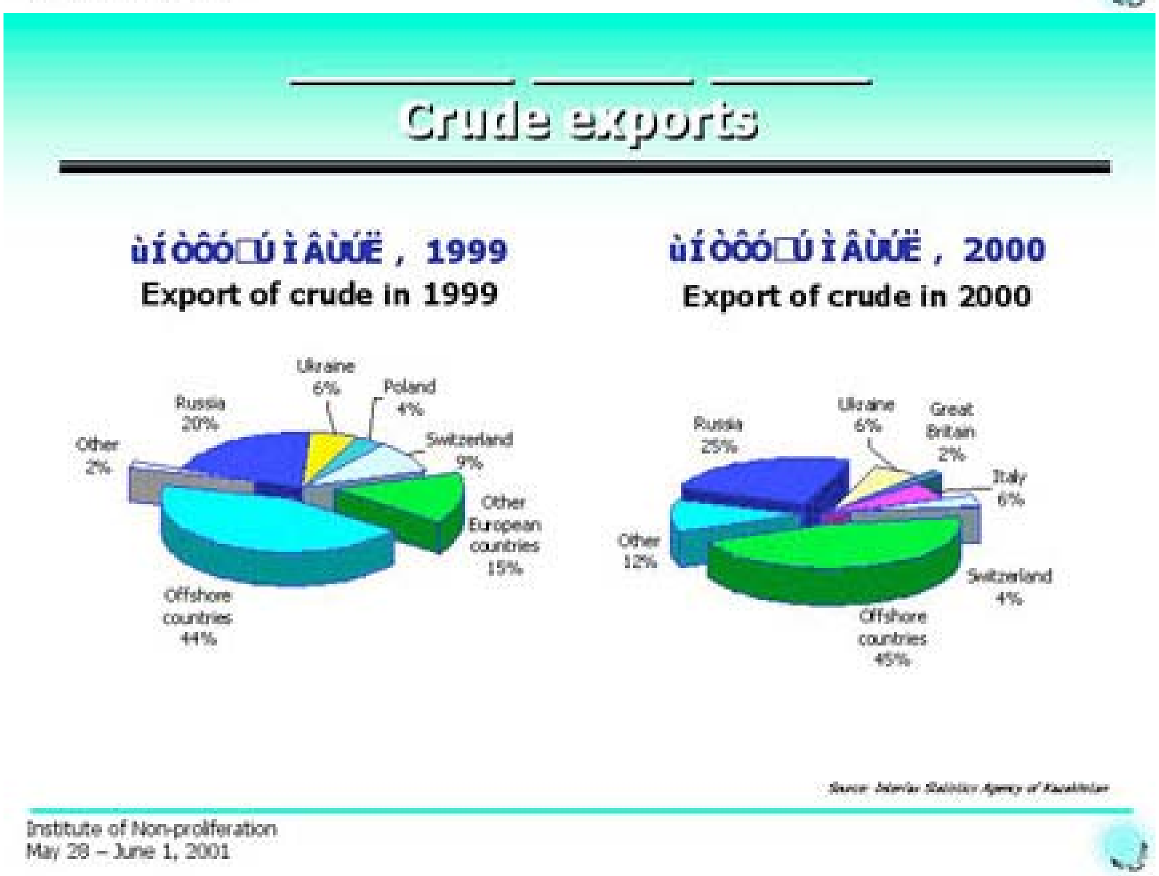
National Nuclear Center of the Republic of Kazakhstan

Physical Protection of the Kazakhstan Petroleum Assets: Tyupkina






Industrial Production
Oil&Gas Industry
Other Mining Industry
Processing Industry
Energy Resources Industry
42%
4%
45%
9%
Institute of Non-proliferation
May 28 – June 1, 2001


Crude exports
Export of crude in 1999
Russia 20%
Ukraine 6%
Poland 4%
Switzerland 9%
Other European countries 15%
Offshore countries 44%
Other 2%
Export of crude in 2000
Russia 25%
Ukraine 6%
Great Britain 2%
Italy 6%
Switzerland 4%
Offshore countries 45%
Other 12%
Institute of Non-proliferation
May 28 – June 1, 2001

á‡Ô‡Ò° ÌÂÙÚË Ë „‡Á‡
Oil and Gas Reserves

éÚÍ ˚Ú˚ı ÏÂÒÚÓ˛ÓÊ‰ÂÌ ËÈ:

- çÂÙÚflÌ˚ı – 172
- äÓÌ‰ÂÌ Ò‡ÚÌ˚ı – 42
- É‡ÁÓ˚ı – 94

Discovered Deposits:

- Oil – 172
- Condensates – 42
- Gas – 94

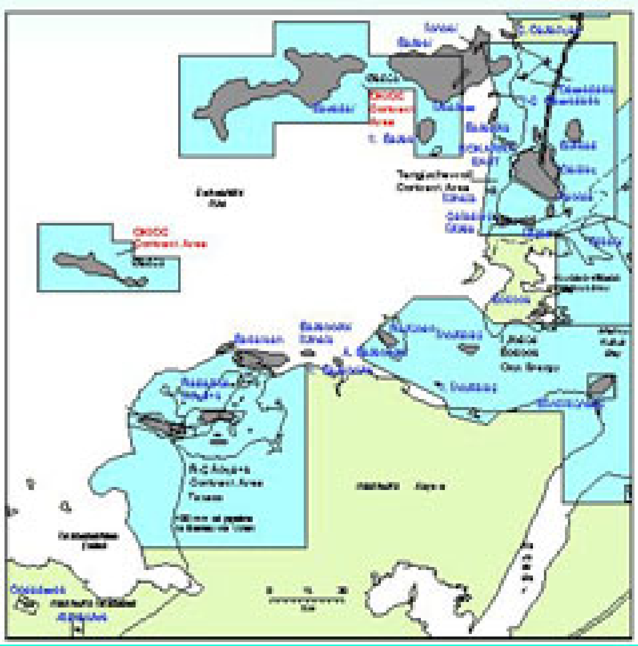
êÁ‚Â‰‡ÌÌ˚Â ËÁ‚ÎÂ͇ÂÏ˚Â Á‡Ô‡Ò˚:

- çÂÙÚË Ë ÍÓ̉ÂÌ Ò‡Ú‡ – 2.8 ÏÎ ̇ÚÓÌ
- É‡Á‡ – 1.9 ÚÎÌ. Í Û·. ÏÂÚ

Discovered Extractable Reserves:

- Oil and Condensates – 2.8 Bln.tons
- Gas – 1.9 Tln. cub. meters

åÂÒÚÓ˛ÓÊ‰ÂÌËfl ÌÂÙÚË Ë „‡Á‡
Oil and Gas Deposits



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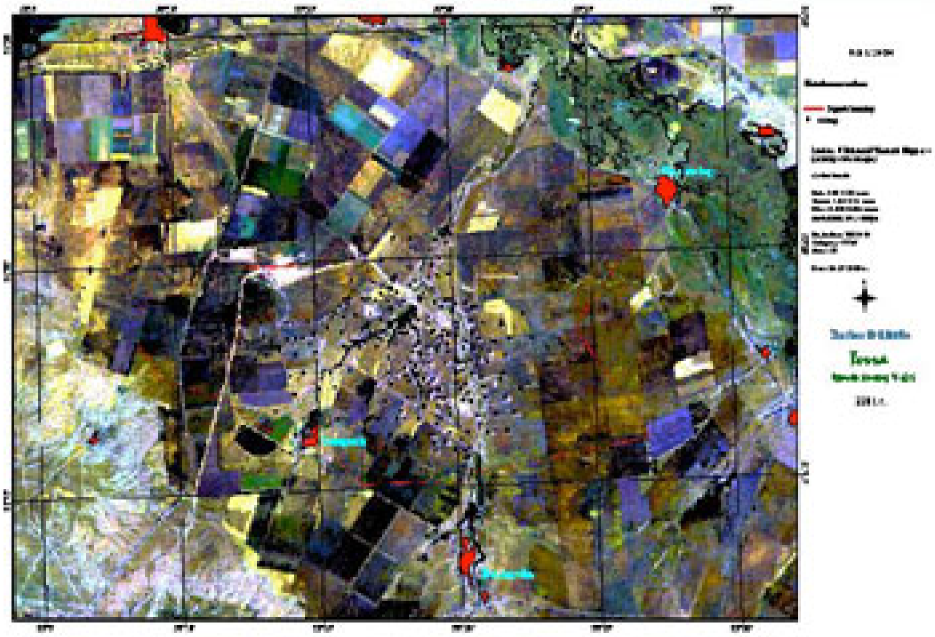
Oil and Gas Deposits



Institute of Non-proliferation
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åÄÖÚÓ□ÖÉ%åI Ëfl IÁÚÚË Ë „‡Á‡
Oil and Gas Deposits

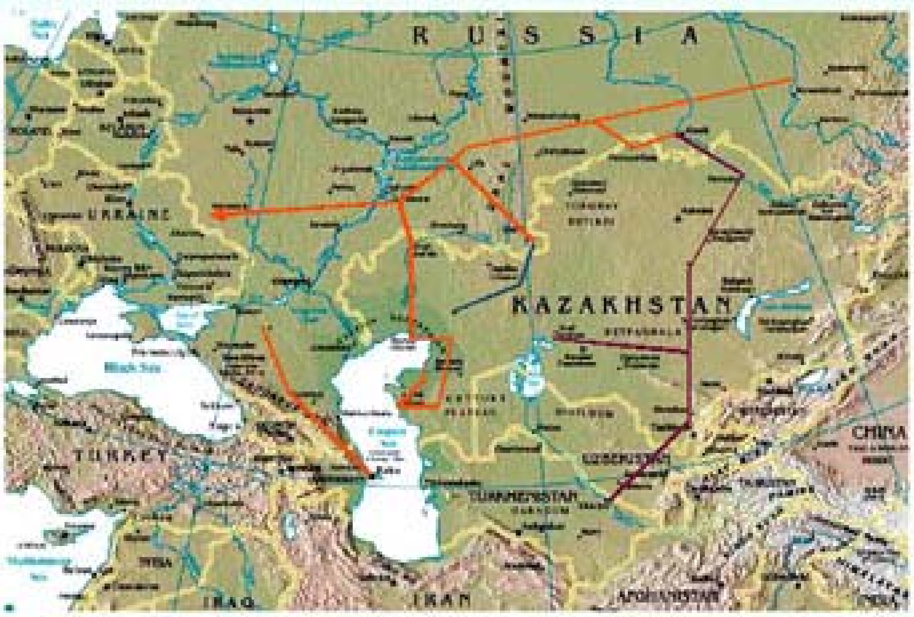
Institute of Non-proliferation
May 28 – June 1, 2001

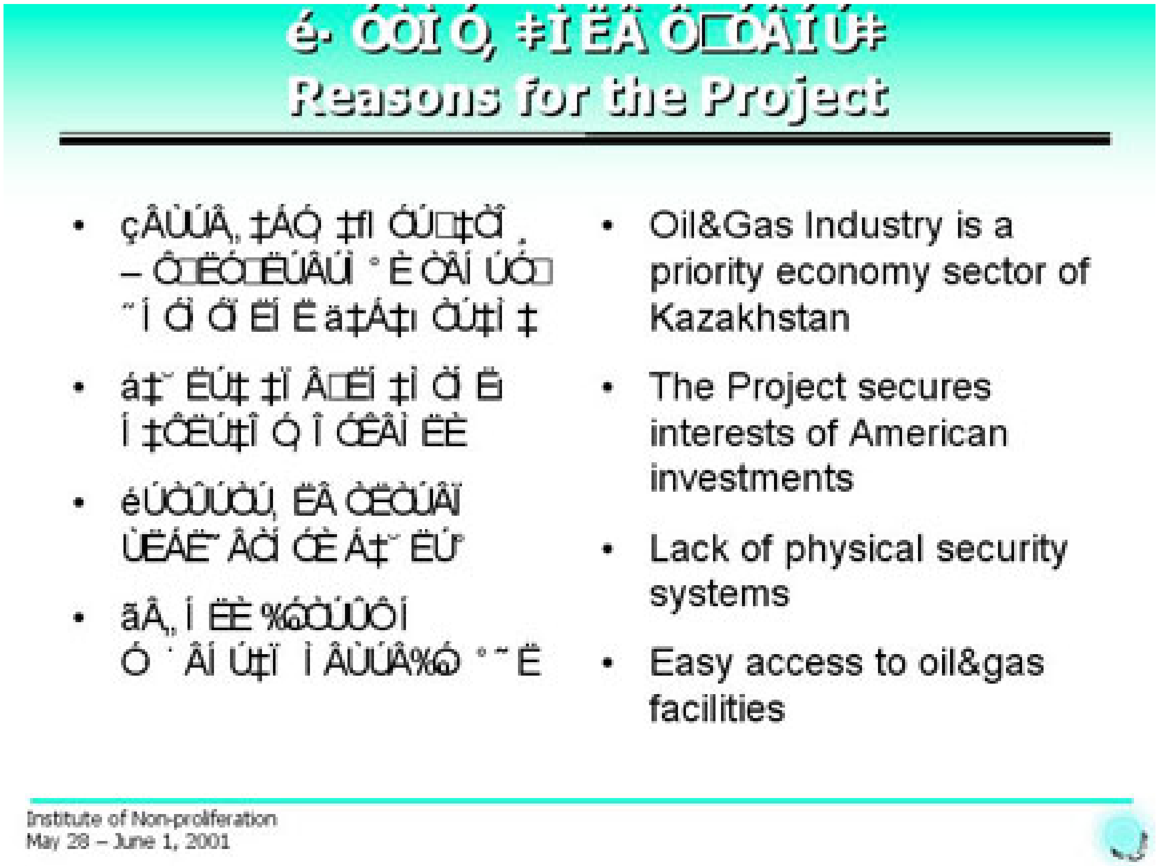
ë□Â%òàÚ, ‡ Ú□‡Ì ÒÔÓ□ÚË□Ó, ÍË ÌÂÙÚË
Means of Crude Transportation

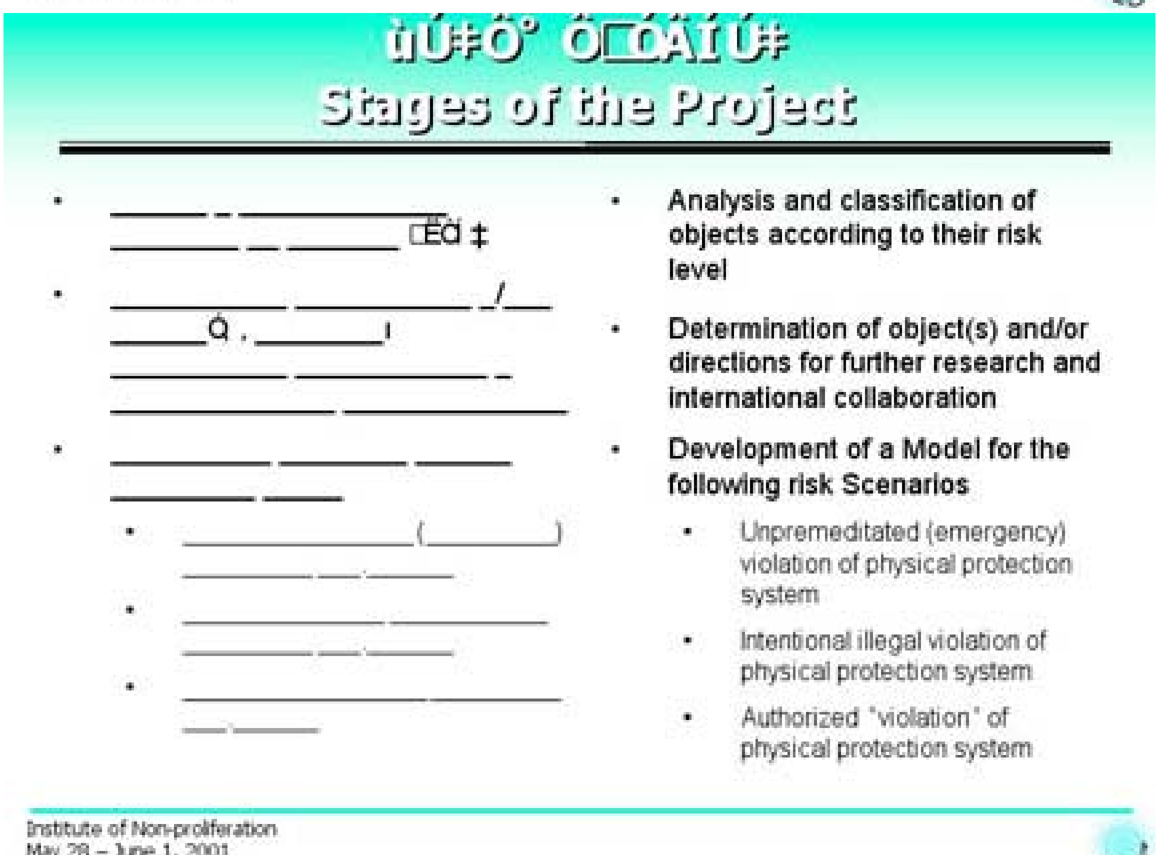
	________ ________ËÐ, ÌË/By means of transport, %:		
	__________/Pipeline	_/_ /Rail	____/Sea
Kazakhstan	**60**	**31**	**9**
Í ÃÌ „ËÁÒÂ, □ãËÎ /Í éé	30	60	10
Mangystau	76		24
Uzen	35	65	
Emba	82	18	
Tengiz	100		
Aktobe	78	22	
Karazhanbas	10		90
Others	100		

Source: Interfax Statistics Agency of Kazakhstan

ÑÂÈÒÚ, Û¸˘ËÂ ÌÂÙÚÂÔ□Ó, Ó%o
Existing Pipelines




Reasons for the Project
Oil&Gas Industry is a priority economy sector of Kazakhstan
The Project secures interests of American investments
Lack of physical security systems
Easy access to oil&gas facilities
Institute of Non-proliferation
May 28 – June 1, 2001


Stages of the Project
Analysis and classification of objects according to their risk level
Determination of object(s) and/or directions for further research and international collaboration
Development of a Model for the following risk Scenarios
Unpremeditated (emergency) violation of physical protection system
Intentional illegal violation of physical protection system
Authorized "violation" of physical protection system
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May 28 – June 1, 2001

Stages of the Project

- Development of physical protection system for chosen object(s)
- Conducting of Model experiments according to Scenarios
- Working out of recommendations for system introduction onto real facilities

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May 28 – June 1, 2001

Market Research and Targeting

Steps of the Market Research (I Stage):

- List of Oil&Gas companies
- Research Methodology
- Research Instruments
- Pilot Testing
- Data Collection
- Data Analysis
- Results Check and Confirmation
- Depth Interview

Institute of Non-proliferation
May 28 – June 1, 2001

Other Submitted Material (English)

Conversion of Semipalatinsk Test Site

O.Tyupkina
Institute of Non-Proliferation, Almaty

Decision about creation of Semipalatinsk Nuclear Test Site was made by Central Committee of the Communist Party of Soviet Union and Council of Ministers of the USSR on August 21, 1947. First subdivisions of the site (military unit 52605) started re-deployment in the concentration area on June 1, 1948.

Semipalatinsk nuclear test site is located on the territory of three regions of the Republic of Kazakhstan: Eastern-Kazakhstan, Pavlodar and Karaganda. Initial area of the site made up of about 5200 square kilometers. Later this area was increased approximately to 18500 square kilometers. Since 1947 there were started works on preparation to tests, construction of required structures. In 1949, simultaneously with preparation of objects and structures for conducting nuclear tests, there was constructed settlement (today is Kurchatov-city) on the bank of Irtysh river, which was transformed later into administration center of the site. The settlement was located in 120 km far from Semipalatinsk on the bank of Irtysh river and in 60 km to north-east far from the test site. Later all surface nuclear explosions of Semipalatinsk test site were conducted on this site.

Since 1989 there was not conducted any explosions of nuclear facility on the test site territory. On August 29, 1991 in accordance with Decree of the President of the Republic of Kazakhstan № 409 Semipalatinsk nuclear test site was closed.

On May 15, 1992 in accordance with Decree of the President of the Republic of Kazakhstan № 779 there was established National Nuclear Center of the Republic of Kazakhstan on the basis of complex of former Semipalatinsk test site, corresponding scientific organizations and objects located on the territory of Kazakhstan. Structure of NNC of RK is made up of institutes located in Kurchatov-city: Institute of Atomic Energy, Institute of Radiation Safety and Ecology, Institute of Geophysical Researches, Regional Medical-diagnostic Center, and Institute of Nuclear Physics located in Alatau settlement (near Almaty).

Underground explosions were conducted both in vertical (133 explosions in holes) and in horizontal (215 explosions in tunnels and boreholes) holes designed for laying nuclear facilities on Balapan, Sary-Uzen and Degelen sites.

Practice of radiation researches showed that fractional presence of formed radioactive substances in global and local (100-150 km) contamination is a determining factor for formation of radiation situation to the moment of testing. Taking into account this factor, nuclear weapon tests on Semipalatinsk test site can be divided into 2 stages:

1 stage – conduction of surface nuclear tests from 1949 till 1962.
2 stage – conduction of underground nuclear tests from 1961 till 1989.

Geography. Semipalatinsk test site area is located on the left bank of Irtysh river, on the junction of three regions: Eastern-Kazakhstan, Pavlodar and Karaganda. Administration bodies of scientific and production structures of the site are located in Kurchatov-city. General Directorate of the National Nuclear Center of the Republic of Kazakhstan, to which mentioned site structures are subordinated to, is also located in Kurchatov-city. Kurchatov-city is located in 120 km far from Semipalatinsk downstream of Irtysh river and connected with it by rail and motor roads. Total square of Semipalatinsk test site is 18,5 thousand square kilometers. Territory of the site spreads from Irtysh river to the south-western direction at a distance of 180 km.

Hydrology. Test site area located in the eastern part of Kazakh lowhills in arid zone has no rivers with constant stream except Irtysh river, which confines the test site territory from north-east. Among lowhills there are marked valley-forming lowlands, where a large quantity of salt-marshes, salty lakes, dry beds of small and intermittent rivers are marked. The most largest river is Tundyk to the west and Shagan with inflow Ashysu to the east of the test site territory. Valleys of dry beds and intermittent rivers are mainly oriented to north-east. Flood water of Shagan river reaches Irtysh, and Tundyk river flows into salty closed lake.

Semipalatinsk test site region is located in the area of fresh and brackish waters with mineralization up to 3 g/l, and rarely higher. Underground waters of the region are divided into pressure water of Neogene-Palaeogene deposits, underground water of Quaternary and fractured-vein water of Paleozoic formations.

Pressure water. Northern-east part of the region is the southern edge of Ishim-Irtysh artesian basin confined by Kazakh lowhill to the south, and by Altai-Tarbogatai fold highlands to the east. Palaeogene-Neogene and Neogene- Quaternary deposits with stratal pressure water-bearing horizons form the area of Irtysh river valley, partially overlying Paleozoic formations and forming valleys of Tundyk and Shagan rivers. Water-bearing horizons of Palaeogene deposits are represented by fine sands of thickness from 5 to 30 m, occurred at depths from 50-60 m. Output of wells runs up to 10-20 l/s. Waters are mainly fresh, hydrocarbonate-sulphate-sodium with mineralization up to 1 g/l. Sandy-gravel water-bearing horizons of thickness up to 10-25 m are occurred in Neogene- Quaternary deposits at depths down to 30-40 m and have output of wells up to 2-15 l/s. Waters are fresh (0,5 g/l), hydrocarbonate-sulphate-calcic.

Underground water. Quaternary deposits containing horizons of underground water spread throughout the whole area of the region and contain horizons of sands of thickness up to 10-15 m with fresh water and output up to 1 l/s.

Fractured-vein water. Paleozoic formations on outcropped areas, especially in southern-west part of the region, are characterized with fairly wide spread occurrence of fractured-vein waters of hydrocarbonate-calcic composition with mineralization up to 1 g/l. Output runs up to 0,2-0,5 l/s. The main areas of underground water makeup are located in highlands of the region. General direction of underground water flow is northern-east, deep into Ishim-Irtysh artesian basin. Local points of discharge and drainage are small lakes and upflow springs in lowlands, which are often turned into solonetz because of evaporation processes.

Studies of radiation situation on the territory of STS were conducted in 1993 according to task of the Ministry of Ecology of the Republic and related to contamination mainly by cesium-137 of soil or bottom sediments of "atomic" lake Chagan, waters in Degelen mountain complex and Balyktykol lake (near the border of the test site). Fields of radioactive contamination appeared in the process of conduction of nuclear explosions subjected to considerable changes in the course of time firstly as a result of migration processes of various types. Study of migration character of radionuclides with underground water is of great importance and interest, since this process can be resulted in radioactive contamination of potable water supply sources and loss of geological environment with its all resources.

Underground nuclear explosions in holes were conducted on **«Balapan»** site. Holes are vertical openings of 900 mm in diameter partially cased by pipes of different diameter. Depth of holes is 500-600 m. In total there were conducted 136 nuclear tests (196 underground nuclear tests) in holes at Semipalatinsk test site in the period from 1968 till 1989.

Underground waters of Balapan site are mainly confined within zones of exogenous and tectonic fracturing of rocks of Paleozoic foundation. They are exposed at a depth of 2-70 m. Piezometric levels vary from 2 down to 30 m building up water head up to 70 m. Underground waters flow in northern-east direction.

Shagan river of 95 km in length crosses Balapan site and falls into Irtysh river in the north. Along the STS territory Shagan river makes up losses from underground waters running along the places of conduction of nuclear explosions and from Atomic lake.

On site «G», Degelen mountain complex, underground tests were conducted in horizontal mine openings – tunnels. By 1991 181 tunnels with cross-section from 9 to 25 square meters and depth more than 1 kilometer were constructed in Degelen mountain complex. Among them 163 tunnels were used for nuclear explosions. In total 213 nuclear explosions (295 underground nuclear explosions) were conducted in tunnels of Degelen mountain complex in the period from 1961 till 1989.

Most of tunnels incut into mountain complex expose water bearing fracture structures related to the regional underground water basin. Mountain complex rising above surroundings up to 500 m is a vast area of drainage of precipitations that make up underground water basin. Destruction of mountain massif as a result of conducted explosions promotes intensive flushing of explosion cavities. Waters contaminated with radionuclides fall into the system of underground fracture waters and are partially removed with stream of fracture waters from tunnels to surface contaminating near-portal areas with radionuclides. Filtered by friable deposits contaminated waters fall into water bearing horizons of underground waters.

In the process of liquidation of Semipalatinsk test site infrastructure in 1996-1999 there were conducted studies of near-portal areas of tunnels and hydrological studies of hole mouths on Degelen complex and Balapan site. Since 1996 in water bearing tunnels, both in open and closed, there was conducted water monitoring, namely regular measurements of water inflow in portals, precipitation measurements, water sampling and chemical analysis of water for determination of anion-cation composition, general mineralization, contents of radionuclides (cesium-137, tritium) and others. There were analyzed hydrogeological and chemical characteristics of underground waters, concentration of radionuclides in water depending on flow rate, water mineralization and its chemical composition.

During several years (1996-1999) the Institute of Geophysical Researches of NNC of RK in cooperation with Almaty branch of the Institute of Atomic Energy of NNC of RK studied impact of underground nuclear explosions on environment, migration and spreading of man-caused radionuclides on Balapan site.

However, in spite of series of conducted works, study, assessment of character and scales of radionuclide contamination of the STS territory remains topical task important for development of environmental measures. Necessity of works is based on the fact that more deeper level of underground waters has not practically been studied.

Among several dozen lakes located on the test site, there was not studied any natural lake. At the same time bottom sediments of lakes located at different distance from places of surface tests contain information about fall-out of radioactive substances from clouds of nuclear explosions. Accumulation of radioactive substances in bottom sediments took place as a result of their fall-out in solid and liquid forms from atmosphere, flow from land and migration by wind.

Since there was not any man-made impacts on these objects of environment, they are unique sources of information about surface nuclear tests conducted at the test site.

Processes of interaction of radioactive atmospheric contaminants with soil-vegetable cover, effects of sorption and fixation strength of many artificial and natural radionuclides in various soils, regularities of their accumulation by various organisms and transition by food chains depending on ecological and physical-chemical factors have been studied by present time. At the same time these problems were studied on background or relatively mildly contaminated territories, where contamination was caused by other processes, on model facilities, where activity of used radionuclides also was limited and researches had been conducted in a shot period of time.

Researches on the STS territories will allow to study several processes, effects and regularities mentioned above in real conditions created in certain periods of time commensurable with the problem of environmental radioactive contamination as a result of conducted nuclear tests. Radionuclides removed by water streams are in the forms that easily interact with environment, and their content in water and soil can be classified as radioactive waste.

Study of radionuclide contamination of underground waters of the test site is very important in connection with economic use of its territory. Test site territory is rich in natural resources. Geological study of the test site territory is practically just started, however series of large and small deposits are already opened. Under existing situation there is an urgent necessity in immediate conduction of radioecological studies on development of underground water rehabilitation methods and rational nature management recommendations for the STS territory, since uncontrolled development of minerals on the test site can be resulted in their irrevocable loss. At first sight hydrogeological conditions of deposits exploring areas seem to be simple enough from the position of their development by open-cut method. Absence of thick water-bearing formations with considerable natural reserves and resources of underground water allows to consider deposits among medium water-bearing deposits. Conditions for operation of such deposits do not imply arise of any serious difficulties.

However various problems can arise at industrial development of deposits, when geological environment will be subjected to intensive influence. Quarrying more than 100 m in depth will be resulted in formation of vast depression craters in the sphere of influence of which will be areas, where hole cavities of underground nuclear explosions are located. At the same time inclines of piezometric surfaces of underground waters will considerably increase that will cause adequate intensification of migration processes and underground water flow towards open pits. It is impossible now to predict on which stage of deposit development will begin contamination of pit water with radionuclides. In that cases on-line control and quality forecast will be possible only basing on underground water monitoring data.

Solution of the problem of maximum reduction of above mentioned negative environmental affects requires development and realization of the whole complex of measures, among which the most important is underground water monitoring that represents a centralized system of control over condition of underground waters at influence of natural and man-caused factors, assessment and regular prediction of possible changes of quantitative and qualitative condition of underground hydrosphere. Monitoring is to be based on the system of ground, underground, and in some cases aerospace observations that are conducted over certain network of observation posts. Monitoring will not be effective without a complex of measures on constant control over ecological situation in areas of interference of economical activity objects located on the STS territory and natural-man-caused systems surrounding them. It is important to determine boundaries of such interference and, hence, areas of monitoring zones. Outlines of areas, which will be covered by monitoring network, will be regularly corrected as soon as new data received.

Above stated clearly demonstrates urgency and necessity of thorough study of Semipalatinsk test site water basin effecting on vast region.

Main stages of activity “Volcovgeologia”

1948-1953ies. Organization of wide searches of radioactive materials, development of methods of their carrying out, searches of uranium deposits in Kendyktas-Shu-Iliyski district. Exploration of uranium deposits - Kurday and Botaburum.

1953-1956ies Opening and detection of The North-Kazakhstan uranium province.

1957-1968ies The first finds of uranium deposits “Uchkuduk” in Paleogene depositions of Shu-Sarysu depression

1969-1980ies Opening and exploration of unique hydrogenous (bedded- infiltration) on stores deposits uranium in Shu-Sarysu depression and Illu. coal-bearing basin.

1981-1991ies Exploration and preparation for commercial operation of uranium deposits in Shu-Sarysu basin for leaching extraction.
Opening and exploration of deposits of copper, gold, polymetals and building stones In Southern Kazakhstan.

1992-2001ies Execution of technological drilling for uranium productions firms Southern Kazakhstan, detailed exploration of deposits Akdala, Tortkuduk, Southern Karamurun.
Exploration of polymetal deposits Rodnik and Kyugan Maibulak group of copper deposits, estimation of gold ore objects. Carrying out prospect-estimated work and drillings in territory of CHINA. Carrying out specialised radio-ecologo-hydrogeochemical researches in different party of Kazakhstan.
Carrying out geological-survey operations in scale 1:500000 - 1:200000 in territory of The Southern Kazakhstan.

Main directions of operations

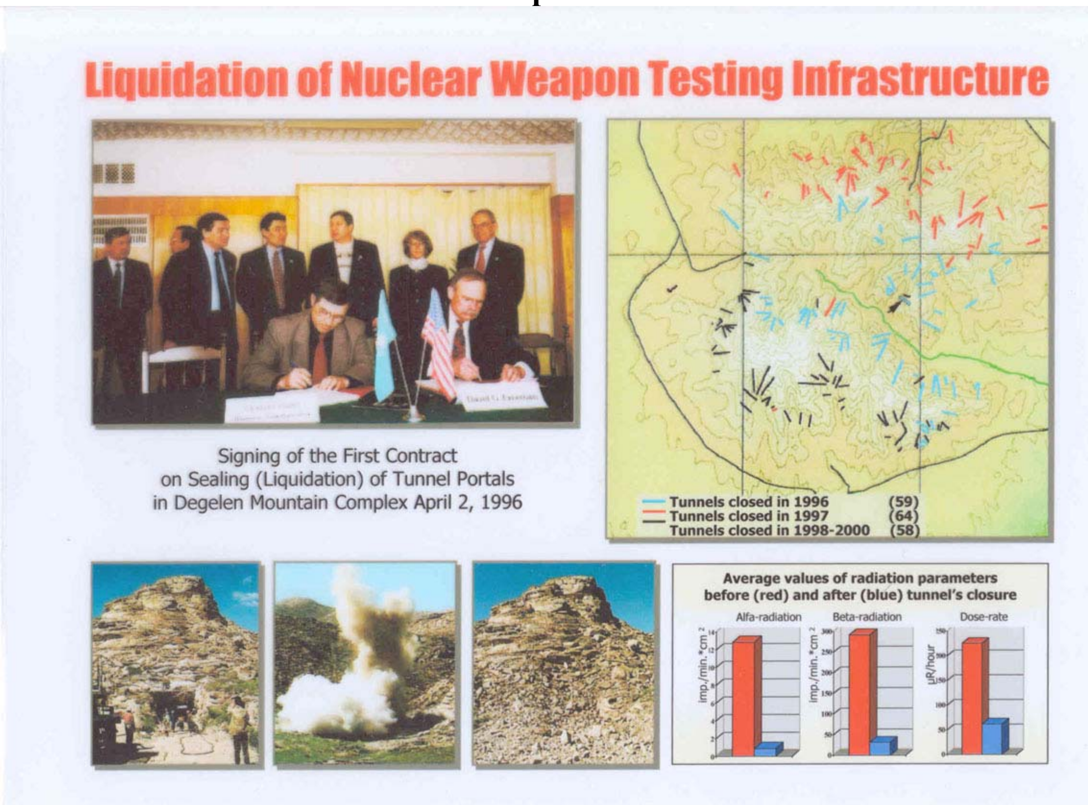
1. Studying perspectives of uraniferous resources, searches and exploration of bedded-infiltration uranium deposits (“standston” type) for extraction by is-leaching, compilation of the feasibility REPORT of quality requirements and records with count of resources and assertion them in State Committee on Resources in the Republic of Kazakhstan.
2. Drilling and building of technological wells on exploited uranium deposits.
3. Completion of detailed exploration of deposit Akdala with carrying out full scale experience on is-leaching of uranium and by-product compounds by productivity 250м/ч together with JV KATKO, detailed exploration of a deposit Tortkuduk.
4. Hydrogeochemical inspection and monitoring of underground waters in districts of uranium mining by is-leaching.
5. Estimate of environmental impact of uranium mining by is-leaching.
6. Radioecological researches in districts with intense radioactive conditions and in districts of oil fields.
7. Geologic survey of operation in scale 1:200000 and 1:50000 in Southern Kazakhstan.
8. Searches and exploration of deposits of copper, gold, polymetals and raremetals in Southern Kazakhstan.

Main directions Central Scientific Research Laboratory:

▪ Carrying out researches on new development and perfecting of modern techniques of laboratory proof tests for ores and estimation of geotechnological conditions of bedded-infiltration deposits, it is aimed to the choice of optimal parameters of uranium extraction with the help of the newest development realised at immediate involvement IAEA;
▪ Development and perfecting of techniques of alpha tests of ores intended for a heap leaching, including uranium, gold, copper;
▪ Carrying out researches to estimate a radioecological state and effective ways of recultivation of underground waters and grounds in districts of intensive uranium mining by is-leaching
▪ Analysis of chemical composition of different ores, concentrates, solutions, drinking, natural and sewage water and other objects;

Centre Scientific Research Laboratory are realising:
▪ Spectral semiquantitative analysis on 10, 28 and 41chemical elements, the spectrochemical analysis of gold, quantitative definition of silver, rhenium, scandium, vanadium, complete technical analysis of coals;
▪ Chemical analysis of uranium, rhenium, germanium, molybdenum, total of rare earths, selenium, cobalt, silver, fluorine etc., and also atomic absorption analysis of gold, copper, Zincum, leads, wolframium;
▪ X-ray spectral analysis on uranium, thorium, lead, Zincum, selenium, arsenic, molybdenum, copper, rubidium, zirconium etc., and also silicate analysis;
▪ The gamma - spectrometer analysis on radium -226, 28, thorium - 228, potassium - 40, cesium - 137, cobalt - 60, antimony - 125, церий-144, ruthenium - 106, integral analysis an alpha, it is beta also gamma - radiation, an alpha - spectrometer analysis of polonium - 210, uranium - 238,234, thorium - 232,230, plutonium 239-240, 238 and spectrometer it is beta the analysis lead -210 and strontium-90;
▪ physics-mechanical characteristics of soils and ores;
▪ the mineralogist analysis;
| Bucking and comminution of geologic tests to 0,074мм

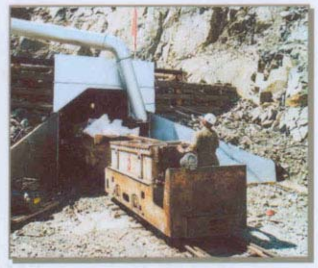
Liquidation of the Kazakhstan Nuclear Weapon Infrastructure: NNC

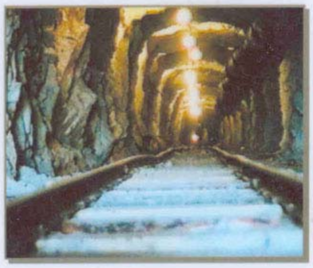


Liquidation of Nuclear Weapon Testing Infrastructure


Tunnel #214 - "OMEGA-1"


Tunnel #160 - "OMEGA-2"


Tunnel #160 - "OMEGA-3"



CALIBRATION EXPERIMENTS

Nuclear Weapons Testing Control

Seismic Stations & Arrays in Kazakhstan


Seismic Data Center in Almaty


Seismic array PS23 at Makanchi.
Mounting of a Three-Component Seismograph

Radiation Control and Radioecology

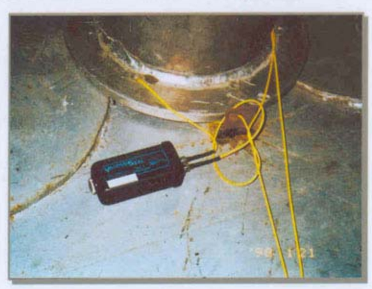
Mobile radioecology laboratory

Tritium measurement in water

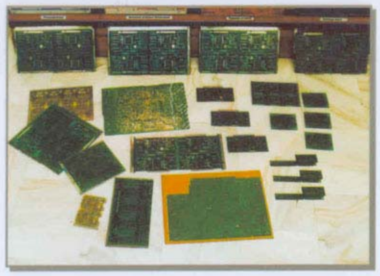
Portable Gamma-Spectrometer

Non-Proliferation

Improvement of the Physical Protection Systems, Nuclear Materials and Facilities Control and Accounting at the NNC RK reactor complexes



Kazakhstan-American JSC "KK Interconnect"



AMPS mission (1996-1997).

AMPS - technology of Earth remote sensing. All obtained information has delivered to the Kazakhstan part.

Goals:

❖ collection, processing and analysis of information;
❖ evaluation of possibilities to use AMPS at the Industry of the Republic of Kazakhstan;
❖ approbation of the American technology in Kazakhstan;
❖ training of Kazakhstan specialists at the fields of computer processing methods.

Partners

From the RK

- Ministry of Science-Academy of Sciences
- National Nuclear Center / Administration
- Semipalatinsk region / "ABC" holding company
- "Semtex" joint enterprise
- Institute of Cosmic Researches
- "Semey Comirleri" / "Geotex" company

From the USA

Department of Energy / Pacific North-West Laboratory (PNL)
Remote Sensing Laboratory (RSL)
Sandia National Laboratory (SNL)
Naval Research Laboratory (NRL)
"Earth. Search. Science" Company (ESSI)

Results:

- analysis of earth cover at the Charyn river region; / non-proliferation control at the Degelen region;
- city planning of Semipalatinsk; / examination of the geological conceptions for store of minerals resource;
- search of the minerals at the territory of Semipalatinsk Test Site; / designing of train-branch line

Activity provoking global interest

- ✓ Elimination of armaments activity remains
- ✓ Problems of nuclear waste disposal
- ✓ Monitoring of regional objects – potential transporter of particularly dangerous agents

- ✓ Management and development of protection technologies of industry objects
- ✓ Counteraction to illegal using of particularly dangerous materials

Analysis of the RK Tax Code on the presence of benefits to the certain kind of activity or entity form (May 2000):

1. Income tax from the juridical 30% and individuals from 5 to 30 % (takes from the total annual revenue – funds and other means to production, services and other operations)
2. VAT 20% (turnover of works, services and import), 10% - for the foodstuff
3. Excisable goods (sport, alcohol, jewelry, oil, weapons, motor transport etc.)
4. Fees at issues, which not are subject of the State registration from 0.1 to 0.5%
5. Special taxes and payments of the bowels users (exists special system/model)
6. Social tax from the wage fund 26%
7. *Passenger fare
8. Land-tax (about 0,1% to assessed value)
9. Assessed tax
10. Tax to a travel facilities

10-1. Single tax

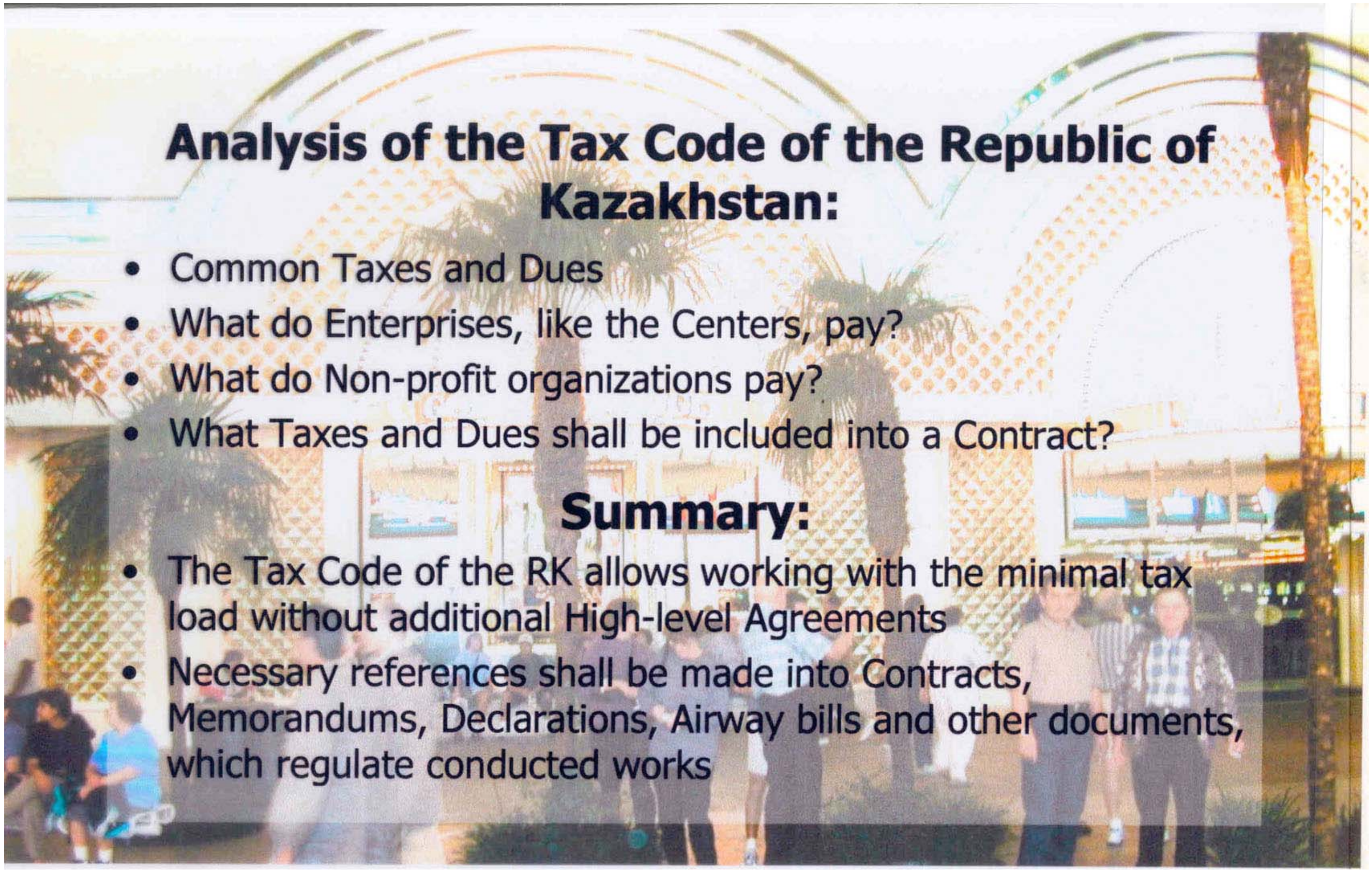
11. *Registration fee
12. *License tax to have a right for the take up of individual kind of activity
13. *Dues from the auction sale
14. *Due to the power of sale in the market
15. *Payment to the use of radio-frequency resource
16. **Due to the use of symbolism of Almaty city
17. * Due to the use of state symbols
18. *Due to the purchase of foreign currency

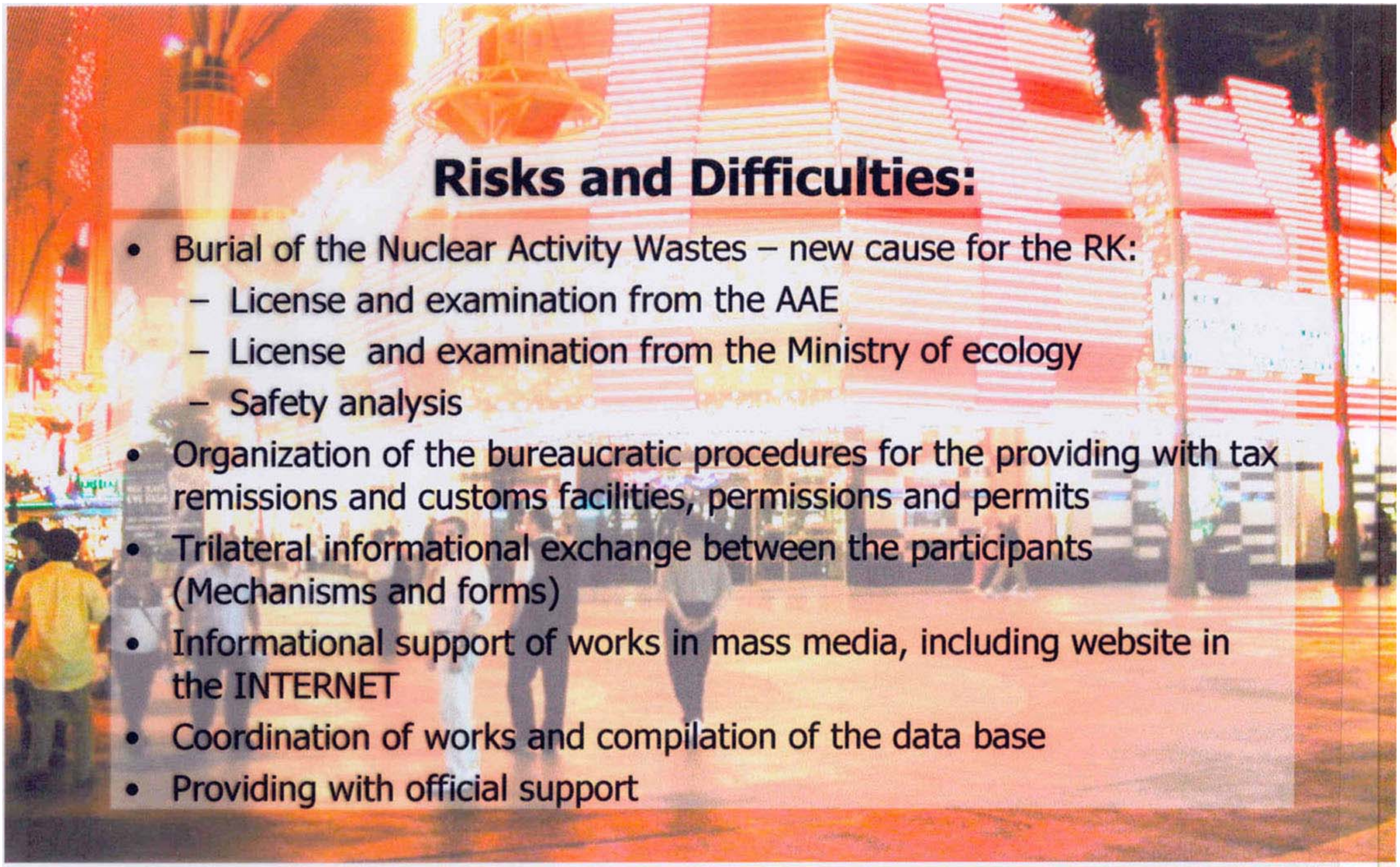
(*) Amount of payment determines by the Government decrees

(**)Amount of payment determines by the solution of Almaty City Administration

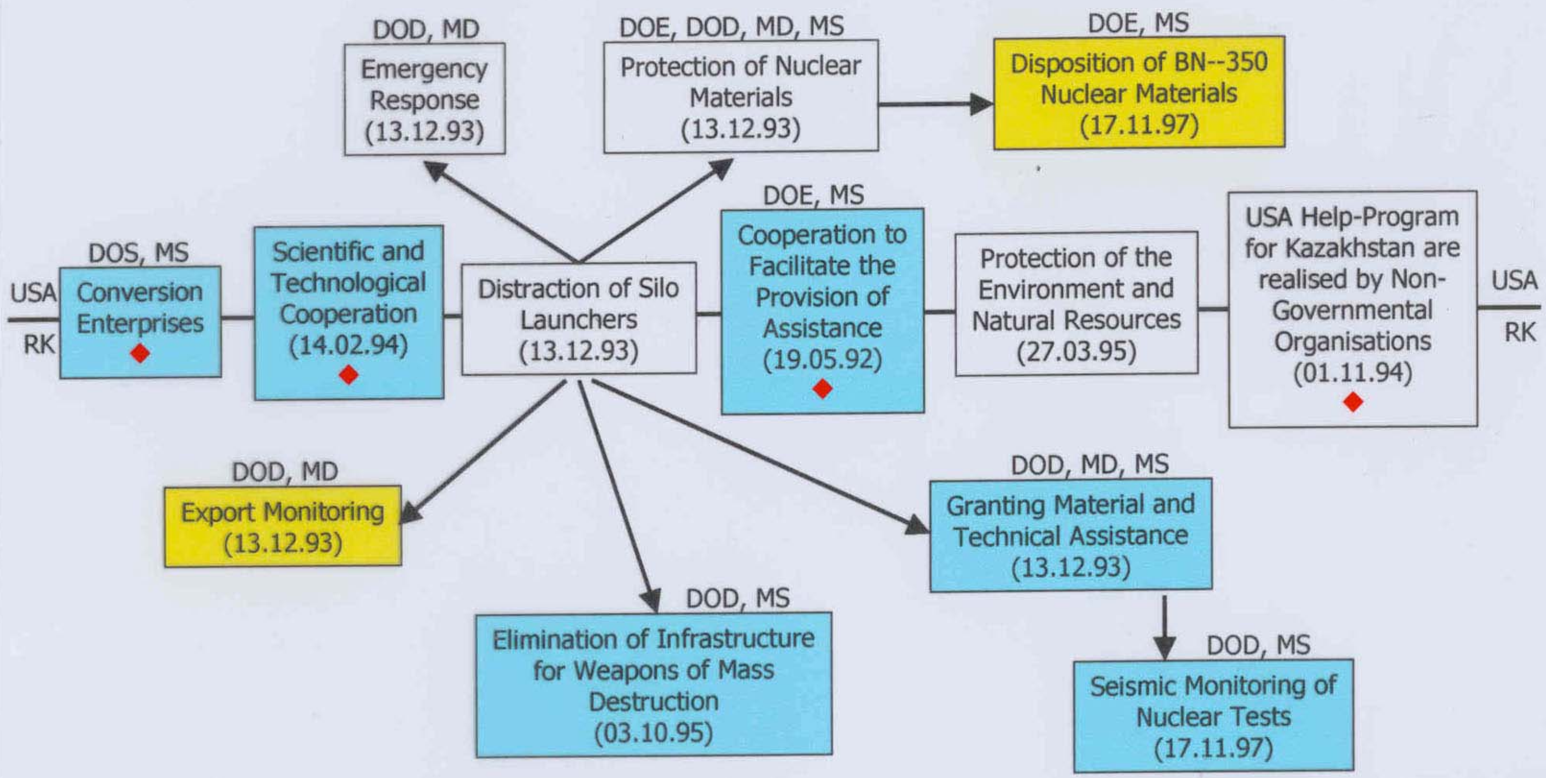
Analysis of the RK Tax Code on the presence of benefits to the certain kind of activity or entity form (May 2000):

Type of organization or kind of activity	Income tax (income) from a juridical person	VAT 20% (turnover of works, services and import)	Social tax	Pension assessments (from individuals)	Income tax from individuals	Other payments
Profit organizations	30 % of income	20 % of turnover	26 % of wage fund	10 % of wages	from 5 to 30 % of wages	customs fees, dues etc.
Nonprofit organizations	exempt, if the funds obtained on basis of grant	Exempt for works, services in the field of culture and science				
Research and development activity	exempt, if the funds obtained on basis of grant					
Grants		Works and services are exempt	exempt			
International activity	International organizations by the Government list are exempt	Works and services for international traffic are exempt				Rules of international agreement are used
Investment						Rules of the contract with the authorized investment agency are used


Analysis of the Tax Code of the Republic of Kazakhstan:
• Common Taxes and Dues
• What do Enterprises, like the Centers, pay?
• What do Non-profit organizations pay?
• What Taxes and Dues shall be included into a Contract?
Summary:
• The Tax Code of the RK allows working with the minimal tax load without additional High-level Agreements
• Necessary references shall be made into Contracts, Memorandums, Declarations, Airway bills and other documents, which regulate conducted works


Risks and Difficulties:
• Burial of the Nuclear Activity Wastes – new cause for the RK:
– License and examination from the AAE
– License and examination from the Ministry of ecology
– Safety analysis
• Organization of the bureaucratic procedures for the providing with tax remissions and customs facilities, permissions and permits
• Trilateral informational exchange between the participants (Mechanisms and forms)
• Informational support of works in mass media, including website in the INTERNET
• Coordination of works and compilation of the data base
• Providing with official support

List of Agreements



AIN
Association Institute of Non-Proliferation

Signed Protocol for Semipalatinsk Proposal

Russian Version

Протокол
Совещания по выбору участка для моделирования гидрогеологических условий СИП

Присутствовали:

От Института гидрогеологии и гидрофизики МОН РК проф.Веселов В.В., директор, доктор технических наук, Джакелов А.К., зав.лабораторией ресурсов подземных вод, доктор геолого-минералогических наук, Паничкин В.Ю., ведущий научный сотрудник, кандитат технических наук.
От Института геофизических исследований НЯЦ РК Меленьтев М.И., заведующий лабораторией, кандидат геолого-минералогичепских наук, Коновалов В.Е., заведующий отделом
От Института ядерной физики НЯЦ, Субботин С.Б., ведущий инженер.

После обмена мнениями решили:

1. Для создания гидродинамической модели рекомендовать площадку Балапан.
2. Для создания модели миграции радионуклидов рекомендовать участок Заречный в пределах площадки Балапан.

Проф.Веселов В.В.

Д.г.-м.н. Джакелов А.К.

К.т.н. Паничкин В.Ю.

К.г.-м.н. Мелентьев М.И.

Коновалов В.Е.

Субботин С.Б.

English Version

Minutes
Working Group Meeting for Choosing a Location for Hydrogeological Modeling at STS

Participants:

On behalf of the Institute of Hydrogeology and Hydrodynamics, RK Ministry of Education and Science,

Prof. V. V. Veselov, Doctor of Science, Institute Director,

A. K. Dzhakelov, Doctor of Science, Director, Ground Water Resources Laboratory,

V. Yu. Panichkin, Candidate of Science, Leading Research Fellow,

On behalf of the Institute of Geophysical Research, National Nuclear Center, Republic of Kazakhstan,

M. I. Melentyev, Candidate of Science, Laboratory Director,

V. E. Konovalov, Department Head,

On behalf of the Institute of Nuclear Physics, National Nuclear Center, Republic of Kazakhstan,

S. B. Subbotin, Leading Engineer,

After discussion, it was decided:

5. To recommend the Balapan site for a flow (hydrodynamic) model.
6. To recommend the Zarechny site within Balapan for a radionuclide transport model.

Prof. V. V. Veselov

A. K. Dzhakelov

V. Yu. Panichkin

M. I. Melentyev

V. E. Konovalov

S. B. Subbotin